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Design of Visual Indicators page 572

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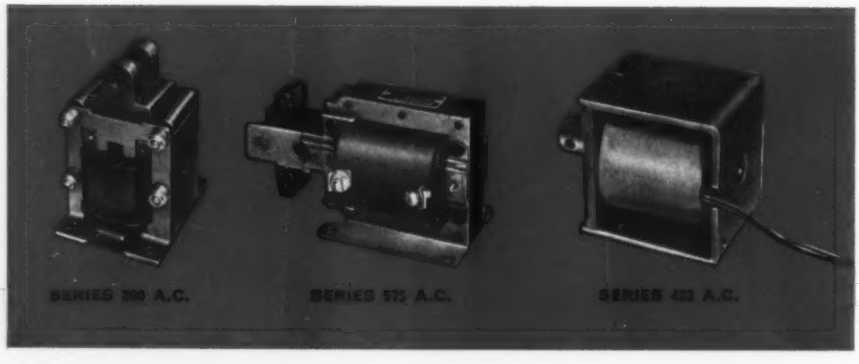

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Engineering Materials and Design

★ *The Magazine for Engineering Designers*

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Abstract impression of the translation of Lansdell digits (which are designed to facilitate recognition in poor visibility) into more familiar figures.

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ISSUE AT A GLANCE

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DESIGN OF VISUAL INDICATORS: PART 1 ... ... **572**

Setting out the design principles to be observed, and giving examples of good and bad design.

By John Spencer

SURVEY OF PIPE COUPLINGS: PART 2 ... ... **582**

Listing the principal manufacturers of the following types of pipe coupling: screwed, welded, brazed, soldered, capillary, flanged, self-sealing and quick-release.

By A. H. Roach

POLYPROPYLENE—THE INSULATOR OF THE FUTURE ... **594**

Brief account of the nature, engineering properties, and basic methods of fabrication of this material.

By G. F. Redgrave

KNOW YOUR METALS—IRON **596**

A simple treatment of the subject of iron and steel, for the junior designer who has not been trained in metallurgy.

By F. Lister

OTHER FEATURES

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Résumés

LE POLYPROPYLENE—L'ISOLANT DE L'AVENIR

par G. F. Redgrave page 594

Cette polyoléfine, qui est analogue au polythène, prend une importance croissante dans l'industrie de la mécanique. L'auteur donne une brève description de sa nature, de ses propriétés mécaniques et de la méthode de fabrication de base.

DESSIN D'INDICATEURS VISUELS: 1ère partie

par John Spencer page 572

Cet article traite du dessin de cadrans indicateurs et d'échelles graduées pour usages industriels généraux. Il formule certains principes généraux qu'il convient d'observer et donne quelques exemples de bons et de mauvais dessins.

CONNAISSEZ VOS METAUX—LE FER

par F. Lister page 596

Une simple étude du fer et de l'acier pour jeunes ingénieurs n'ayant pas eu de formation spécialisée dans le domaine de la métallurgie. L'auteur explique certains des termes métallurgiques couramment utilisés.

ETUDES DES RACCORDS DE TUYAUX: 2ème partie

par A. H. Roach page 582

Cette seconde partie—la première a été publiée dans le numéro d'août—donne la liste des principaux fabricants des types de raccords suivants: vissés, soudés, brasés, capillaires, à brides, auto-soudés et à relâchement rapide.

Kurzreferate

POLYPROPYLEN—DER ISOLIERSTOFF DER ZUKUNFT

G. F. Redgrave Seite 594

Die Wichtigkeit dieses, dem Polythen sehr ähnlichen Polyolefins im Maschinenbau ist im dauernden Anstieg begriffen. Der Verfasser gibt eine kurze Beschreibung seiner Kenndaten, seiner Eigenschaften beim Maschinenbau und der grundsätzlichen Herstellungsverfahren.

KONSTRUKTION VON SICHTBAREN INDIKATOREN—Teil 1

John Spencer Seite 572

Der Artikel beschreibt die Konstruktion von Indikatorskalen und Skalen für allgemeine Zwecke der Industrie. Er erklärt die einzuhaltenden Grundsätze und gibt Beispiele guter und schlechter Konstruktionen.

METALLKUNDE—EISEN

F. Lister Seite 596

Eine einfache Behandlung des Gegenstands Eisen und Stahl für den jungen Konstrukteur ohne metallurgische Schulung, und eine Erklärung einiger allgemein gebräuchlicher metallurgischer Ausdrücke.

ÜBERSICHT ÜBER ROHRVERSCHLÜSSE—Teil 2

A. H. Roach Seite 582

Dieser zweite Teil stellt die Fortsetzung unseres Artikels in der August-Nummer dar und bringt eine Übersicht der hauptsächlichen Erzeuger folgender Types von Rohrverschlüssen: Schraub-, Schweiss-, Hartlot-, Löt-, Kapillar-, Flansch-, selbstabdichtende und Schnellauslöseverschlüsse.

Резюме

ПОЛИПРОПИЛЕН — ИЗОЛЯЦИОННЫЙ МАТЕРИАЛ БУДУЩЕГО

Ф. Редгрэйв Стр. 594

Этот полиолефин, аналогичный полиэтилену, с каждым днем играет все более важную роль в машиностроении. Автор дает краткое описание его природы, механических свойств и основного метода его производства.

КОНСТРУКЦИЯ ВИЗУАЛЬНЫХ ИНДИКАТОРОВ — ЧАСТЬ 1

Джон Спенсер Стр. 572

Эта статья посвящена проблемам конструкции указательных шкал и циферблатов для общих промышленных применений. Делаются некоторые выводы о принципах, которые следует соблюдать, и приводятся примеры хорошей и плохой конструкции.

ПУТЕВОДИТЕЛЬ К МЕТАЛЛАМ: ЖЕЛЕЗО

Ф. Листер Стр. 596

Простое изложение науки о железе и стали для начинающего конструктора без металлургического образования, с объяснением некоторых часто встречающихся металлургических терминов.

ОБЗОР ТРУБОПРОВОДНЫХ СОЕДИНЕНИЙ — ЧАСТЬ 2

А. Х. Роуч Стр. 582

Продолжение статьи, напечатанной в августовском выпуске. Перечисляются главные изготовители следующих видов трубопроводных соединений: винтовых, сварных, припаиваемых крепким и мягким припоем, капиллярных, фланцевых, самоуплотняющихся и быстросоединяющихся.

MATERIALS IN THE NEWS

Monthly Digest of Materials and Design News from Home and Abroad

Aluminium for Car Engines

THE STEADILY INCREASING USE of aluminium in passenger cars to raise the horsepower-to-weight ratio is well recognised, and the development of an aluminium casting alloy suitable for a liner-free engine block would make a valuable contribution to this effort. Progress in this field has been slow, however, mostly due to the generally poor wear resistance of aluminium alloys, although aluminium silicon hypo-eutectic or near eutectic alloys, because of their superior wear properties, have been extensively used for pistons in automobile engines. Theoretically, modified hypo-eutectic alloys should possess an ideal combination of good wear, high strength, low density and low thermal expansion coefficient, but until recently they have been neglected, mostly due to their poor foundry characteristics. These alloys solidify over a wide temperature range during which the primary silicon forms and grows to large particles which float to the surface. This segregation results in excessive variation of properties and difficulty in machining; also the aluminium silicon binary alloys are not age-hardenable, and the resulting soft matrix, which is sensitive to galling, must be hardened by adding copper and/or magnesium.

Recent European studies indicate that the preparation and modification of the melt under controlled conditions results in significant refinement of the primary silicon and the eutectic phases. The U.S. Ford Motor Co. have been exploring commercially feasible modification techniques, and the effects of several modifying agents on the microstructure, mechanical properties, wear and foundry characteristics of these alloys.

An effective cycle of melt preparation of 21 per cent Si alloy, with modification by a copper phosphorus brazing alloy rod, has been developed. With this treatment at a phosphorus level of 0.03 per cent, a consistently high degree of refinement has been obtained, resulting in ultimate-tensile and the yield strengths of 43,000 and 40,000 p.s.i. respectively, a hardness range of 126 to 156 BHN, and 0.5 to 2.0 per cent elongation. Also, the coefficients of thermal expansion of these alloys are 15 to 20 per cent lower than those of the piston alloys. Later tests achieved an ultimate tensile strength of 50,000 p.s.i.

Remelting and superheating of the back stock successively three times, and holding the melt at temperature for 1 to 2 hr., has resulted in little or no loss in refinement. The superior mechanical properties and the low thermal expansion coefficients suggest a potential application of these alloys for automobile engine block and cylinder head castings.

Aluminium for Trains

THE FIRST TRAINS of London Transport's new unpainted aluminium alloy cars (for the Metropolitan Line services to Amersham, Chesham and Watford) are of a completely new design, and will run in four-car units, two units being used together in peak hours to form an eight-car train. Each unit consists of a driving motor car, two intermediate trailers, and another driving motor car. All the axles of the driving car are motored.

The seating capacity is considerably larger than that of any other London Transport saloon-type stock. Air-operated sliding doors and fluorescent lighting are fitted, and an innovation in London Transport saloon stock is the provision of parcels racks. The car bodies are of unpainted aluminium alloy, parts of the structural members of the body forming the exterior face of the cars—this locally eliminates panelling and panel riveting.

The bogies are built up of welded sub-units which are stress-relieved before riveting together, the bodies being carried on the bogies by centre plates and side rollers. Hydraulic dampers are fitted to control the vertical and lateral movement of the bolsters.

Double block braking, with non-metallic brake blocks carried in cast steel brake heads, is used on all wheels. An individual brake cylinder with slack adjuster unit is used for each brake block. Radial-type positive and link-type negative collector shoes are fitted to all the motor bogies. The negative shoe beam is carried on an arm supported between the bogie headstock and motor, and the positive shoe is carried on a laminated wooden shoe beam rubber-mounted from the axleboxes.

The bodies of the new Metropolitan Line cars were designed by Cravens Ltd., and the bogies designed under the direction of the chief mechanical engineer at London Transport's Acton works.

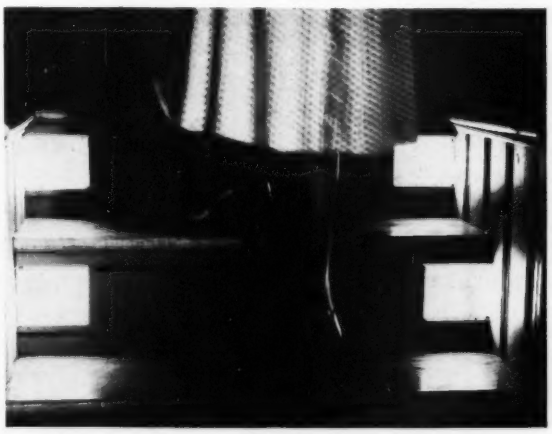
New Fluorescent Light Source

A NEW CONCEPT of lighting appliances has been developed in the U.S.A., as the result of prolonged research. Engineers of the Westinghouse Electric Corp. have produced large, thin rectangular glass plates, no more than 1¼ in. thick, which produce fluorescent light. These unusual lamps actually consist of a labyrinth of passages sealed in a thin glass block. The arc or electric discharge travels this winding path through the glass block to produce, in effect, a large area source of light.

The prototype (shown below) is 1 ft. square, with compact rear contacts, and is designed for use in modular fashion. The 12 in. square models will be 40 to 50-watt lamps, and will produce considerably more light than a 100-watt incandescent bulb. The lamp will have a reflector on one side so that all the light will be reflected through a single side of the lamp. Attractive pattern glass will be used on the front to control the brightness and direction of the light, and to produce a pleasing, decorative effect.

Because the new lamp requires only a skeleton fixture with practically no depth, it can drastically reduce the amount of ceiling space required for mounting. This means that a multi-storied office building, for instance, need not be quite so tall, thus resulting in substantial savings to the builder.

Another advantage claimed for the flat fluorescent lamp is reduced maintenance costs. In present fluorescent fixtures, it is necessary to clean the fluorescent tubes, the reflector and the diffusing element of the fixture. Since in the labyrinth-type lamp all of these three elements are combined into one, it is necessary only to clean the outer glass surface of the lamp.

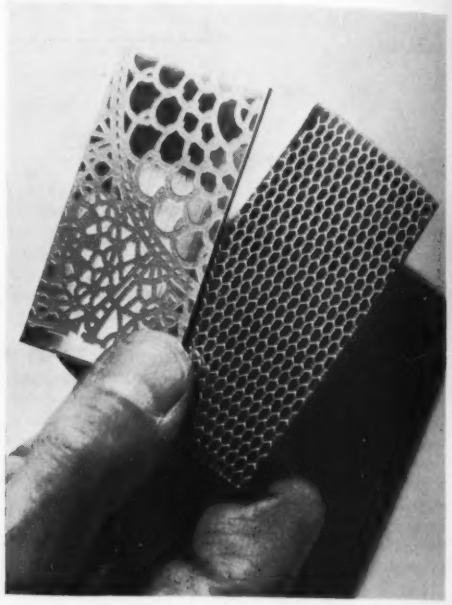


BUBBLES SIMULATE ATOMS

Because soap bubbles have a tendency to join and balance in much the same way as atoms, the bubble technique shown above is used to duplicate atomic structures in metals. The actual space between each atom is six million times smaller than is shown by the model.

ROLLER PRINTING

Decorative and functional finishes on metal strip have been produced at the British Iron and Steel Research Association by cold rolling a cheap expendable pattern of paper, linen or man-made fibre with the strip. The pattern may be placed either on one surface, or sandwiched between two lengths of strip.



PICTURE NEWS

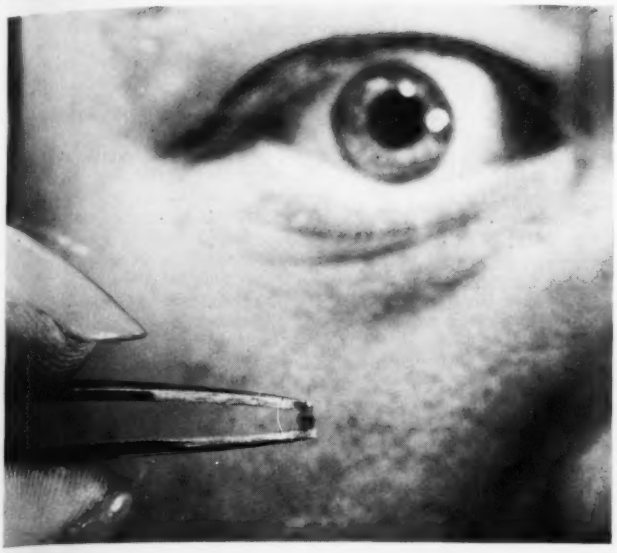
IN THE WORLD OF MATERIALS & DESIGN

NEW TRACK-LAYING VEHICLE

London Transport have recently brought into service a specially-constructed train for handling the 300-ft. long welded rails used on many sections of the London Underground system. The above picture shows the end of a conductor rail being lifted onto a head-stock roller.

DOCUMENT DESTRUCTION

The Fordigraph heavy-duty paper-shredding unit is operated by a single lever, and can instantly destroy confidential and private records. The narrow unreadable strips of paper fall directly into a polythene bag, as shown. The cutters are self-sharpening, and are not damaged by pins or staples.

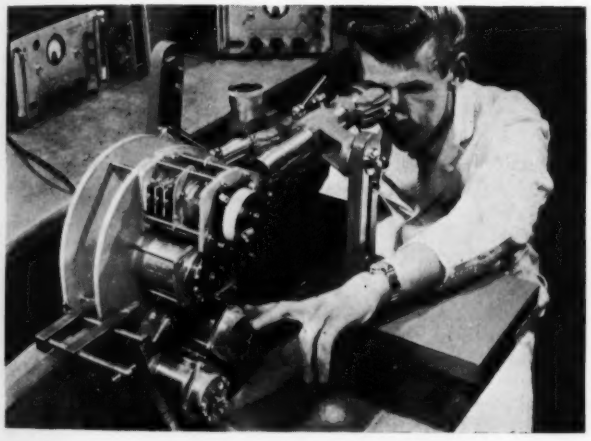


MICROMINIATURE SEMI-CONDUCTOR

The Dot diode produced at the laboratories of Hughes International (U.K.) Ltd. is the latest achievement in the development of microminiature semi-conductor devices for airborne computers.

TRANSISTORS CONTROL POWER DISTRIBUTION

The control console of the world's first remote-controlled supervisory system for the distribution of electric power is shown on the right. Using transistorised equipment made by General Electric Co., of the U.S.A., this unit eliminates the need for manual operation and visual checks of line equipment, and controls three remote substations.

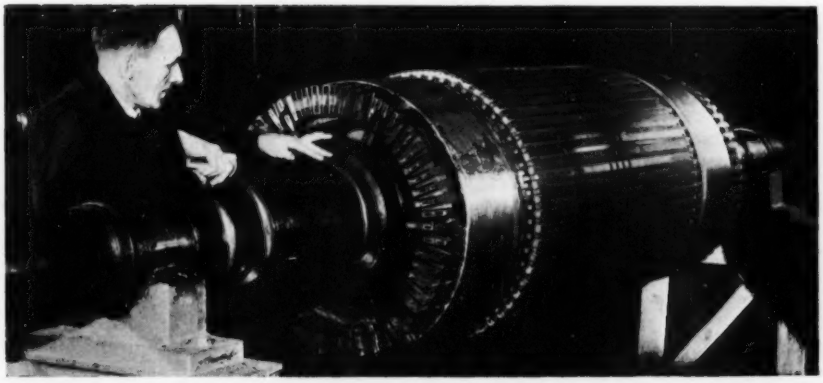


NEW HEADQUARTERS FOR SOLARTRON

Instruments, specialised equipment and various machines and systems were demonstrated and exhibited at the recent opening of the new headquarters of the Solartron Electronic Group Ltd., at Farnborough. In the left-hand illustration, an engineer can be seen examining a gearbox for a Solartron X-ray spectrometer.

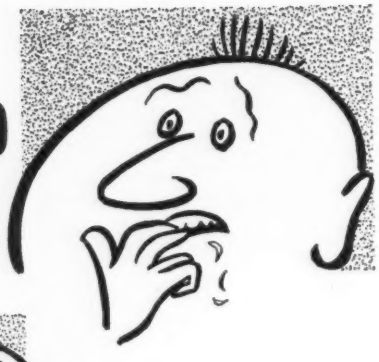
AIR-COOLED ROTOR

An English Electric 2,560-h.p. air-cooled rotor for a slip-ring induction motor is shown on the right. The conductors, through which cooling air is passed, are made from hollow rectangular-section copper.



Must have Steel Castings..

..but delivery?



..let's see..

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Non-destructive Testing Conference

A SUMMER CONFERENCE on non-destructive testing is to be held at Chester, from September 21 to 23, 1961. The theme is to be "Industrial Radiology Today," and it is intended to base the papers and discussion on the application of newly developed aspects. The papers will include such subjects as low kV. radiography, Xeroradiography, linear accelerators, betatrons, large gamma ray sources for radiography, and current safety regulations. The conference is open to all who are interested, whether they are members of the Society or not. A conference fee of 15s. for members, and 30s. for non-members will include the cost of morning and afternoon refreshments.

It is planned to open the conference on the afternoon of September 21 with a works visit to either the de Havilland Aircraft Co. Ltd., Broughton, or the Shell Oil Refinery. A choice of visits will be provided, although numbers may have to be limited. A dinner for those participating in the conference and their ladies is to be arranged for the evening of September 22. Dress will be informal, and there will be a guest speaker for the occasion.

International Design Congress

DESIGN POLICY FOR CORPORATE BUYING will be the theme of the Third International Design Congress, which is to be held this year by the Council of Industrial Design from October 4 to 5. (The previous Congress was in 1956, and dealt with the integration of the designer with management.) The programme will illustrate that design policy in corporate buying is a keystone in building successful industrial, commercial, government or educational organisations, and results in increased efficiency, better working conditions and improved sales and service.

The opening address at the Congress (attendance at which will be by invitation) is to be given by the Minister of Works, the Right Hon. Lord John Hope, M.P., who will be followed by Sir Duncan Oppenheim, chairman of the Council of Industrial Design.

The major part of the Congress's work will be done in three discussion groups. Each group will represent a wide variety of interests, for, although the character of organisations may vary, the problems of initiating, managing and executing a design policy are similar. The three groups will each hold three sessions, to hear and discuss short papers presented by some two dozen distinguished speakers. The principal subjects will be "Design Policy," "Design Practice" and "Trade Repercussions."

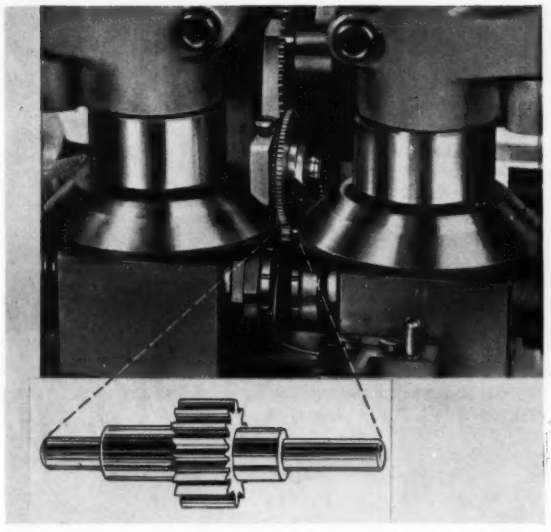
Pivot Polishing

PIVOT POLISHING is a metal-removing process intermediate between grinding and filing, and should not be confused with burnishing, where surface finish is produced by pressure between rotating but non-cutting rollers. It is a positive metal-cutting process, used widely in the watch industry, and makes possible a high degree of geometrical accuracy.

The cutting tool is a solid disc of tungsten carbide or aluminium oxide ceramic, of which the operating surfaces (the face and periphery) are prepared by dressing with a diamond wheel. This dressing produces a large number of fine cutting edges, the grain of which is inclined to the axis of the work by approximately 15°.

Machines are designed in single- and double-spindle forms. On the single-spindle machine the work is supported on a carbide Vee and driven by colleting the opposite end, the polishing wheel being fed onto the workpiece until a pre-set stop has been reached. The rotary interaction of the work and wheel ensures the roundness of the pivot, and the infeed governs the accuracy of the diameter. The double-spindle machines are primarily intended for machining both pivot points of small pinions. Here the work is supported in two carbide discs and driven through its own teeth. In both methods it is possible to machine simultaneously the journal face of the pivot as well as its shoulder. It is also possible to polish fillets and tapers by dressing the wheel to the required profile.

When very small components are to be machined the polishing process is advantageous in that the polishing wheel retains its size very much longer than a grinding wheel and virtually no abrasive dust is generated during the operation. There are two phases of the operation—during the first the polishing wheel cuts like a grinding wheel. During the second the wheel changes to a smoothing and polishing action to attain a higher surface finish than is possible by grinding under similar circumstances. The process is applicable to all materials commonly used in light engineering for pivots, bolts and shafts, including hardened steel.



Because of its nature as a high-precision finishing process, stock removal should be limited to the minimum, which means that during the preceding semi-finishing operation the nominal size should be approached as closely as is permitted by the inherent inaccuracy of that process. When these tolerances can be held to 0.0002 in. or 0.0003 in., polishing tolerances can be held to 0.0001 in., and surface finishes of 2 or less micro-inch r.m.s. are possible.

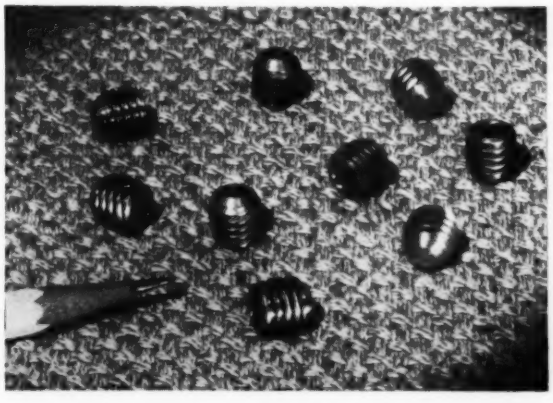
The manufacture of this type of machine is a speciality of Henri Hauser Ltd. of Bienne, Switzerland. The U.K. sales are handled by Wickman Ltd., of Coventry.

Free-cutting Stainless Steel

UNIVERSAL CYCLOPS STEEL CORP., of the U.S.A., have recently announced the commercial availability of a new free-cutting chromium-nickel stainless steel, designated Uniloy 303MA. This new grade of the chromium-nickel austenitic group is similar to AISI Type 303 (17 to 19 per cent Cr, 8 to 10 per cent Ni), but has a much greater corrosion resistance.

In the new steel, optimum combination of aluminium and sulphur additions for better machinability makes it possible to reduce the sulphur content to about one-half the level normally contained in a stainless steel of this type. When significant quantities of sulphur are added to stainless steels for improved machinability, undesirable side effects result, the sulphur content taking the form of non-metallic stringers and inclusions. These non-metallic inclusions cause considerable difficulties in rolling and thread-forming operations. The superior mechanical and corrosion-resisting properties of Uniloy 303MA are, to a great extent, the result of cleaner steel obtained by the use of a low sulphur content.

The new material can be electropolished to a very high lustre, satisfactorily arc-welded, flash-welded, percussion stud-welded and brazed when proper techniques are used.



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Tecalemit Nylon Tubing almost halves fitting times; is free of internal abrasive scale; resists shock, even below −70°C; resists most solvents, corrosion and fungal attack; is unaffected even by strong ultra-violet light, and form-stable over a wide temperature range.

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Following in the great tradition of Nylon Tubing, Tecalemit present a new High Pressure Nylon Hose. More durable, flexible, lighter, stronger and more stable than any other hose on the market. And highly competitive in price! Ask for details when enquiring about Tecalemit Nylon Tubing.

T695

Plastics Wind Tunnels

Hatfield Technical College

WHEN THE HATFIELD TECHNICAL COLLEGE AUTHORITIES first considered a new wind tunnel they thought in terms of a conventional wooden or metal structure. The idea of using plastics materialised during their discussions with The Stanboro' Pattern Co., one of the companies invited to submit quotations, and after building a scale model, work on the full scale tunnel was authorised.

The tunnel is nearly 8 ft. long, the diameter ranging from a minimum of 2 ft. to a maximum of 4 ft. It is fabricated in sections of various lengths from ¼ oz. glass cloth, 2 oz. glass mat, and Epophen epoxide resin manufactured by Leicester Lovell & Co. Ltd. The particular grade of Epophen resin selected has a slight natural resilience—a harder resin could craze when subjected to the stresses which the wall of a wind tunnel might have to withstand.

The circumferential joints are sealed with ¼ in. dia. rubber in a groove pre-formed in the flanged surface, while the longitudinal joints are sealed with a plastics sealing strip; the tolerance specified on all dimensions was ± 0.031 in. A number of removable inspection hatches, each having a central square window of I.C.I. perspex, are incorporated; the corner vanes are fabricated from 16 s.w.g. aluminium sheet. The tunnel is bonded with chopped glass fibre and Epophen epoxide resin to an angle-iron frame fitted with anti-vibration rubber cushion feet.

Although it is too early to be dogmatic about the advantages a plastics wind tunnel might have over more conventional structures, the better surface finish will undoubtedly result in lower frictional losses in the circuit. The main purpose of the tunnel is to supplement lectures with practical demonstrations. Students at Hatfield will also have the opportunity to carry out their own experiments in pressure plotting and measuring forces on aircraft models.

English Electric Co.

Another wind tunnel where plastics were found to be advantageous is the one now in use at the English Electric Co.'s mechanical engineering laboratory at Whetstone, Leicester. This tunnel was designed by them and made at their Rugby works, and is one of a number produced by the same method for the laboratory at Whetstone; it has a 4 ft. dia. inlet section and an 8-in. dia. test section.

The tunnel laminate, of woven glass cloth, chopped strand mat and Bakelite polyester resins, was made in sections over wooden formers. The static pressure taps were moulded into the walls, together with ready-tapped metal inserts for manometer connections. The advantages found in using reinforced plastics for this tunnel were extreme lightness, good internal finish, and a saving in machining time.

Original Work on Component Replacement Policy

A THESIS which may help motor accessory manufacturers to improve the planning of production schedules has been propounded by Dr. Charles Kendrick, who recently held the Kenward Memorial Fellowship at Birmingham University. (This fellowship was set up in 1948 in memory of Sir Harold Kenward, a director of the Dunlop Rubber Co.)

Dr. Kendrick, who is now with the quality control department of Joseph Lucas Ltd., based his research on a close study of a number of vehicle components, including tyres, and has shown that these components become due for replacement according to a predictable pattern. Generally speaking a few will be damaged or wear out, and have to be replaced, early in life. The number of replacements will increase to a peak after several months or years, but a few of the components, gradually diminishing in numbers, will continue in service for much longer. From this information, which has to be studied for each individual product, a standard probability curve can be constructed. By taking each month's sales and aggregating the curves for replacements arising out of those sales, it becomes possible to predict with considerable accuracy the total replacements that are likely to be needed for any month far into the future.

These facts have, of course, been recognised for some time, but it is doubtful if they have been studied so extensively before, especially with such a wide range of components and using the most modern statistical techniques.

The knowledge that has been gained should be of use in the design office. For example, components shown to have a life considerably in excess of requirements could obviously be redesigned with advantage.

Soldering Magnesium

DUE TO A PERSISTENT OXIDE COATING it is difficult to solder magnesium and its alloys, and preparation of the surface by copper plating is hindered by vigorous reaction between the magnesium and the usual plating solutions. It is, however, possible to plate the surface with zinc from a sodium zincate solution. This should be followed with an electroplated copper or nickel coating 0.0002-0.0003 in. thick, and then with an electroplated layer of 0.0002 in. tin. Finally the article is immersed in a bath of oil hot enough to melt the tin coating, so that it flows and binds with the copper undercoat.

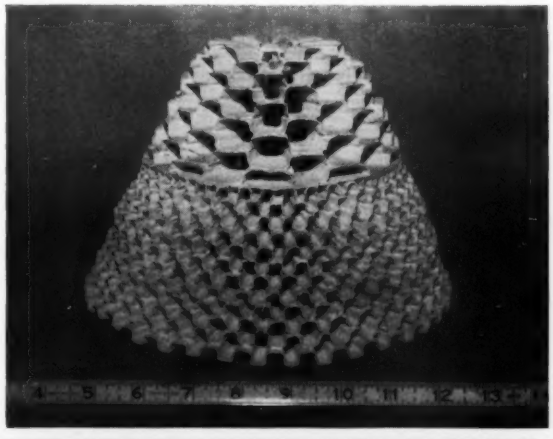
This flow tinning method may also be used in preference to dip tinning for copper and brass, because it is possible to maintain closer control of the tin coating thickness.

Refractory Paper Ceramics

THE GENERAL OBJECTIVES of a recent study by Bell Aerosystems Co. were first, to establish target temperatures and strength requirements for areas where refractory inorganic materials would be useful as aircraft structural components; second, to develop techniques for fabricating refractory inorganic materials into components for use at temperatures of 1,100 deg. C. and above; and finally, to evaluate the effectiveness of the techniques by determining the mechanical properties of the composites thus prepared. Specific attention was given to selection of techniques suitable for the commercial fabrication of all kinds of curved hardware.

The silica, alumina, and alumina-silica systems were selected for fabricating ceramic honeycombs, and were based on the availability of ceramic fibres, cloth, and paper suitable for fabricating ceramics stable at temperatures of more than 1,100 deg. C.

An inherently continuous mechanical process was thus developed for corrugating inorganic paper suitable for fabricating honeycomb cores. Although the ribbons processed were only about 1 in. wide, the process should be applicable to sheet-width materials, and since the process basically depends on the use of inorganic refractory fibres and cements, it can be adapted to many refractory systems—graphite, zirconia, alumina, silica, thoria and silicon carbide. The method enables all kinds of curved geometric shapes to be made from honeycomb ceramic sandwich constructions, the final fired sections having apparent densities as low as 26 lb./cu. ft. Alumina silica paper impregnated with an alumina silica slurry was used as a refractory model system for developing this fabrication technique, the paper originally acting as a carrier but finally becoming an integral part of the fired refractory.



Controlling the Rate of Corrosion

BY DIRECT MEASUREMENT of the rate of corrosion, it is possible to eliminate guess work in its control. The Corrosometer, developed by Winston Electronics Ltd., creates a new standard in the measurement of corrosion in process and storage plants in very many industries, by giving a swift direct reading of the corrosion rate in less than a minute. By using this instrument and its probes the efficiency of anti-corrosion methods may be ascertained, and remedial action carried out at the appropriate time, thus eliminating accidents, damage to plant and hold-ups.

By a system of probes, this single instrument, which is operated from either the mains supply or a battery, can measure the corrosion at a considerable number of points. The probes consist of an exposed specimen of the material concerned, a reference specimen, and a check specimen. The reading from the probe is directly in micro-inches or cm. on the meter without removal of the specimen, and all metals and alloys may tested. The Corrosometer determines the progress of the corrosion on the metal specimen by measuring the increase in electrical resistance as the cross-section of the specimen is reduced by corrosion, and is quite independent of system temperature and environment. The probe is based on the fact that the electrical conductivity of metals is very great, while that of non-metals is negligible by comparison. The corrosive action on the exposed specimen converts the metal into a non-metal, and thus the electrical resistance of the metal probe increases as the corrosion proceeds on its surface. The resistance ratio is then determined between the exposed specimen and a companion coated reference specimen made of the same metal.

A third short check specimen, also coated for protection, is used to verify the corrosion reading. Constant measurement between check and reference specimens shows that the protective coatings of the probe are intact. The test-points of the three probes together are compared.

No cleaning, weighing and analysis of the specimen is required. The sensitivity of the instrument is such that it will detect one-tenth of a microinch penetration of a 1-mil. strip. The voltage on the probe is only 2 to 10 millivolts.

Expanded Metal for Heat Transfer

AN INTERESTING USE of expanded metal mesh to facilitate heat transference is to be seen in a new food processing plant recently put into operation at Mallow, in Ireland. This plant, which is said to be the first of its kind in the world for treating various foods for easy storage and transportation, is designed to freeze and then dry material so that the water content is vaporised without passing through the liquid stage.

The accelerated freeze-drying process, as it is called, was originally evolved by the British Ministry of Agriculture, Fisheries and Food, and has now been further developed and made available to food manufacturers by Vickers-Armstrongs (South Marston) Ltd.

THE OCTOBER ISSUE

of *Engineering Materials and Design* will include the following main features:

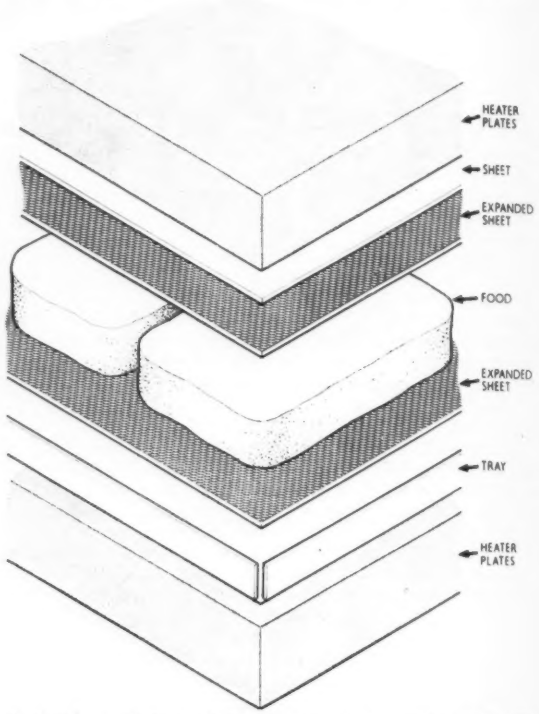
Survey of Pipe Couplings: Part 3
This part concludes the survey, and deals with the following types of pipe coupling: flexible, swivel and rotating joints; and couplings for glass pipes.

Design of Visual Indicators: Part 2
In this second and concluding part of his article the author discusses the design of quantitative moving-scale indicators, and also summarises the aspects dealt with in Part 1.

Development of Heat-treatable Titanium Sheet Alloys
Comparison of two high-strength beta titanium alloys.

Vibration of Beams in Bending
The Rayleigh equations for calculating the fundamental frequency of bending vibration of a heavy beam without concentrated loads are described.

With conventional dehydration of food, the water moves continuously to the food surface where it evaporates and deposits a residue of salts. To avoid this—and the subsequent shrinkage and formation of hard skin—food can be first frozen and the ice then removed by sublimation from the solid phase, leaving the structure and components of the dried food exactly the same as the original frozen food. This is known as freeze-drying, which in the past has required a processing time of up to 24 hr. per batch. In the new method of accelerated freeze-drying marketed by Vickers-Armstrongs, this time is cut by about two-thirds by means of a new technique of transferring adequate heat to the product; the process has thus reached the point of commercial application.



During freeze-drying, sublimation from the ice surface in the food occurs at a rate which depends on the rate at which heat is supplied to it, and on the resistance to the flow of water vapour away from it. The highest sublimation rate can be achieved by applying maximum heat to the food when the resistances to both heat transfer and vapour flow are least, i.e. at the start of drying. If heat is applied by direct thermal contact between the heating surface and food, it is possible to apply maximum heat at the start of drying provided that this does not cause the frozen food surfaces to thaw. This has been managed in the new plant by a novel application of expanded metal.

The heating assembly in the drying cabinet consists of a stack of parallel heating plates between which the frozen food is loaded on trays. The plates, arranged so that close thermal contact is made evenly with both the upper and lower surfaces of each layer of food, are hollow and contain labyrinthed counterflow circuits through which is pumped hot water to a maximum temperature of 140 deg. C.

Each layer of frozen food is sandwiched between sheets of expanded metal mesh which are inserted between both tray and lid and the food surfaces. The configuration of the expanded metal is such that even when mechanical pressure is applied to the food, there is an adequate path through the mesh to allow the escape of vapour. The application of pressure ensures sufficient heat transfer from heating plates to food. The amount of plate pressure applied during drying depends on the natural softness of the food being treated.

This method of using metal mesh by inserting it between heating plates and food is a major advance in accelerated freeze-drying technology, and the product can thus be subjected to adequate pressure over an increased contact area without obstructing the vapour flow. As the pressure is applied after freezing, damage to the foodstuff is avoided and, when later reconstituted, the shape and texture of the product are exactly the same as those of fresh food.

THE HUMAN ELEMENT IN INDUSTRY

FAIR EXCHANGE

ONE of the foremost topics in industry in the post-war years has been that of Industrial Relations. We are being told from many sources what should be done for the man on the shop floor, but it is time we took stock of the real progress made over the years since the beginning of the Industrial Revolution.

First, there have been individual reformers who, by persistence and public agitation, have compelled the Government of the day to legislate to improve bad conditions. This governmental interest has continued until today the worker has a most comprehensive series of Factory Acts to protect his interests. Secondly, the present-day worker is protected by government legislation to an extent undreamed of by the worker of fifty or sixty years ago. Thirdly, we have agitation by organised trade unions, which have done a wonderful job, supplemented and assisted by political influence in the post-war years.

So far as the Factory Acts are concerned, in brief they take care of the health and safety of employees, and lay down a certain standard of amenity. Special regulations are in force for paint shops, building and electrical trades, grinding, and all hazardous jobs; also, the hours of work of women and young persons are governed. Further, we have welfare of the workers, covering all those things which are today desirable but not entirely incidental to manufacture, and which are primarily for the comfort and well-being of the employees.

The trade unions in turn have looked after the earnings of their members to such an extent that the worker today is in receipt of a level of wage, and a standard of living, higher than ever envisaged by our predecessors. Other benefits are: the shorter working week of 42 hours which recently was 53 hours; six statutory holidays with pay; a fortnight's annual holiday with pay; and a guaranteed minimum week. On top of all this, we are cushioned by the Welfare State, and a government policy of full employment.

All these things are probably necessary for the well-being of the community as a whole, and we must work to maintain them. The regulations are there to make the employer a good employer, but, strange as it may seem to some people, there would be many good employers even without regulations. Let us also recognise that a good employer is entitled to good and conscientious employees.

Industrial relations is not a one-sided affair, but a two-way traffic. A good employer providing continuous employment with good working conditions at trade union rates is entitled to expect, without quibble, a fair day's work for a fair day's pay.

Let us recognise that we all have a moral obligation to each other, and that the trade unions and commerce can work together for the good of themselves and the country. Let us also recognise that about fifteen per cent of the working population in receipt of a pay packet do not deserve one, and should not be allowed to shelter under the umbrella of the trade unions. The unions themselves have some responsibility here, as well as the employer, and it is time they faced up to it.

Trade union members should also recognise the fact that the strength of a trade union lies in the quality of its shop floor representation, rather than that at headquarters; therefore they should see that their elected representatives are men of good quality, with a fair amount of common sense, who will not let the organisation down by abusing the office.

The trade unions have done a good job, and should take stock and time to equip themselves so that they and their members can play a full part in a team working together for the mutual good of industry and themselves.

The supervisor on his part should regard the men in his working group as responsible human beings, and treat them as such. In return, the working group should voluntarily accept the authority of the supervisor.

So, with all these benefits, let us "count our blessings" and work together for the common good of industry and country, and by doing so help to maintain the privileges we now enjoy.

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Engineering Materials and Design

NO NUCLEAR PROPULSION FOR BRITAIN

MUCH of the glamour has been stripped from atomic power, and there are now sound economic and strategic reasons why nuclear power will find many new applications. Unfortunately it appears that its application to aircraft is to be the concern of other countries. The seventh annual report of the U.K.A.E.A., recently presented to Parliament, contained a detailed survey of the work that has been undertaken in the past year in connection with nuclear power and its applications.

The Authority have concentrated the greater part of their potential on reactor systems likely to bring great benefit to the electricity-producing industries; other fields of application are atomic weapons and ships. With weapons a great deal of reticence is to be expected, and indeed respected; on the latter application, information is woefully scarce, and appears from the report to be confined solely to envisaging the difficulties of design and operations, and how impossible it will be to compete with conventional power. While obviously there may be something to be gained by awaiting the trials of the U.S. ship *Savannah*, this present whinneying attitude is not one that becomes us, and is most certainly not one that will inspire our atomic energy scientists, who have shown without any doubt that they are among the world's leading men in this field.

This lack of drive in promoting nuclear power for marine use underlines the fact that no consideration has been given to the use of atomic energy for aircraft propulsion. According to Sir Roger Makins, chairman of the U.K.A.E.A., they had not at any time devoted any of their researches to the suitability of reactors for aircraft propulsion, nor were they likely to do so in the foreseeable future. This on the face of things shows a lamentable lack of perception, since the U.S.A. has under active development an aircraft reactor. Furthermore, the U.S.S.R. is reported to have actually flown an aircraft under nuclear power, and the Tupolev company have been ground testing an entirely new system of nuclear power. It is well known that auxiliary power generators (APG) using nuclear power have already been developed: the American Snap I APG employs a radioisotope source, while Snap II has a reactor power source.

The U.S.A. has publicly announced a number of nuclear power units for aircraft and unmanned rockets, and has completed a number of flights with an aircraft carrying a 1-megawatt power output reactor, in order to evaluate shielding problems and the behaviour of systems and materials under flight conditions. The Convair Co. are already preparing advance design studies of nuclear-powered ground-effect machines (GEM) capable of carrying a 15-ton payload.

Charity begins at home, and it is excellent that our domestic needs for electricity have been receiving priority—in this field there is little doubt that we lead the world. Nevertheless it has been shown by the achievements of the U.S.A. and Russia that our inexperience in the application of nuclear power to transport, particularly shipping, is embarrassing.

With all the knowledge that is available to our atomic energy scientists from their research both in domestic applications, and from their work on atomic weapons, there can be no valid excuse for not paying some attention to what will be without a doubt a prime source of power for aircraft at some time in the future.

The reticence of the U.K.A.E.A., and the lack of information available, suggests that this important stage of development is to be left once again to private enterprise, which will we hope rise to the occasion as it usually does, to provide the country with a *fait accompli* at the crucial moment. Private enterprise should provide quick results with less expenditure, but official encouragement and some financial help would be even more reassuring.

The ultimate aim of unlimited cheap electrical power, when achieved, could lift this country back again to a position of eminence. By backing this up with a system of international air transport, we could be in an unassailable position. We have the basic knowledge and skill—we need only a courageous directive.

The Editor

Fig. 1. This watch design of 350 years ago is a beautiful example of craftsmanship by Gaspard Girod, of Geneva. It incorporates three types of visual indicator. (Photograph by courtesy of the British Museum.)

DESIGN OF VISUAL INDICATORS PART 1

This article is concerned with the design of indicator dials and scales for general industrial purposes, where an accuracy, in quantitative terms, of ± 1% of Maximum Scale Values (M.S.V.) will be required

by JOHN SPENCER, M.A.*

IN considering the factors affecting reliability and ease of observation, it might reasonably be asked why indicator design is important, in view of the many instruments which have been used with apparent success throughout industry for the last century or so. A two-fold reply can be made, the first part of which is provided by past experience, and the second by future requirements.

Many indicators can be seen in factories with the glass covered in dirt and the pointers either broken or missing. Most of these units are either not very important, or unsatisfactory as regards design, or are so difficult to interpret that some alternative has been found by the user.

The second part of the reply concerns the increasing tendency to integrate industrial plant elements into larger units controlled by fewer men. The immediate consequence of this is an increased dependence on remote indicators and control, both of which require well designed indicators, since the economic and sometimes physical penalties of error are becoming greater. In addition there is an increase in the number of indicators provided for each man, so that the possible sources of error are increased.

Industry is rapidly reaching a stage which demands high standard indicator requirements found hitherto only in the Fighting Services. It is significant that all the research on indicator design has been initiated by Service problems, because errors were occurring in the use of equipment due to inadequate indicators. As is often the case, no sooner was research started than it was found that a great variety of factors influenced errors in observation, and that slight changes in design could make or mar the usefulness of an indicator.

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Types of Indicator

Indicators can be classified into three basic types, which are fundamentally the same in that they convey similar kinds of information to the user. Their differences lie in the manner of presentation of this information. The first job of the designer is to select the type which gives the best compromise between what the user needs and what the indicator can show. The basic types are:

Quantitative, of which the simplest example is the ordinary pressure gauge or clock. The principal feature of this type is that it allows the user to obtain a precise quantitative measure of the variable which it indicates.

Qualitative, which shows "states" of the plant, element or device to which it is coupled. Motor-car brake lights are an example of a two-state indicator. Traffic lights represent a four-state example.

Representational, in which the indicator simulates an actual situation with as much realism as possible. Examples of this type are harder to give, but some plant mimic diagrams come into this category. The aircraft artificial horizon is another example.

The differences in application of the three types can be illustrated by imagining that indicators are to be provided for lifts in a twenty-storey building. In choosing the best type to use, two groups of people should be considered—the occupants of the lifts, and the would-be occupants wait-

ing for the lifts to arrive.

For the occupants, it is possible to use any of the three types of indicator shown in Fig. 2. For example, the quantitative indicator showing height above ground floor level in ft. could be provided, or alternatively a qualitative indicator showing the floor reached by the lift. Finally, a representational indicator simulating the lift's position relative to the floors could be installed.

Now, if the lift could be operated by the occupants with a push-button corresponding to the desired floor level, after which the lift operated automatically, then the quantitative indicator would be virtually useless. Apart from interest value so would any type of indicator, assuming that the people knew at which floor they entered the lift. But if the lift had to be stopped by the occupants at the right place, some form of indicator would be essential. The quantitative indicator (a) in Fig. 2 would allow very accurate control if a chart of floor height was provided with the indicator. If however the final exact stopping position of the lift was automatically ensured, providing that it reached to within a certain range of positions on either side of each floor, then the qualitative indicator (b) in Fig. 2, actuated by this automatic mechanism, would be a good answer. As soon as the desired floor number lit up the occupant would release the lift control, and the lift would finish the sequence. Lastly, suppose that the occupants have control of speed in addition to controlling directions of travel, and that a high proportion of the users want to travel from top to bottom or vice-versa in minimum time. It can be assumed that the local floor control previously mentioned takes care of the accurate final positioning, and in this situation the representational indicator (c) in Fig. 2 will probably be the most effective for providing information about position, rate of change of position, and a "realistic" frame of reference for the user.

In a similar fashion the best indicator for waiting travellers can be considered, but here the problem is simpler, if only because inactivity is not dangerous. All that the travellers want to know is whether the lift is approaching or going away from them, and how far away it is above or below their floor. This is sufficient to allow them to pick the most favourable lift of the several presumed to be available, but there is still a problem to be solved because there are two ways of displaying this information. As just described, a subjective reference or "floor reference" indicator is suggested so that on any given floor the indicator would tell the would-be traveller what state the lift is in relative to his situation in the building. The alternative method is to use an objective reference or "building reference" indicator which would show the lift state in relation to the building containing it.

This objective reference indication leaves the user to complete some simple mental arithmetic to decide which of several lifts is the best for him to choose. Therefore, unless it is improved, it is unsatisfactory compared to a subjective reference indicator for cases where the number of floors is large and the traffic flow must be maintained at a high level. Fig. 3 shows examples of subjective and objective indicators appropriate to particular cases.

Alternative answers to the problems of lift indicators will almost certainly have occurred to the reader. The purpose in discussing the example has been to highlight the vital relationship which exists between the purpose and type of information required by the user, and the sort of indicator most suited to the requirements.

The example also illustrates the frequently occurring and often unsuspected problem of the best reference to use on an indicator. The choice between either a subjective or an objective reference is usually easy, but sometimes, as in the case of the artificial horizon in aircraft, it can be very difficult. In general, the difficult problem arises with qualitative

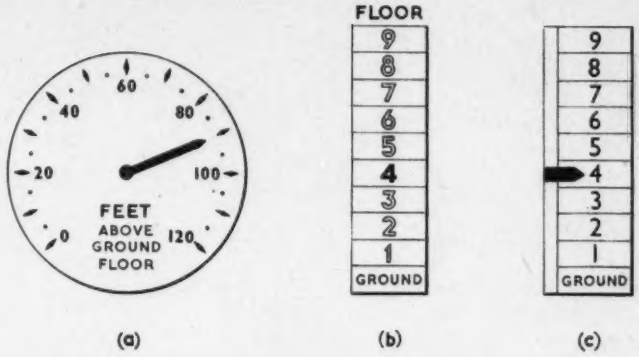


Fig. 2. Three alternative designs of indicator for use in lifts: (a) quantitative; (b) qualitative; and (c) representational.

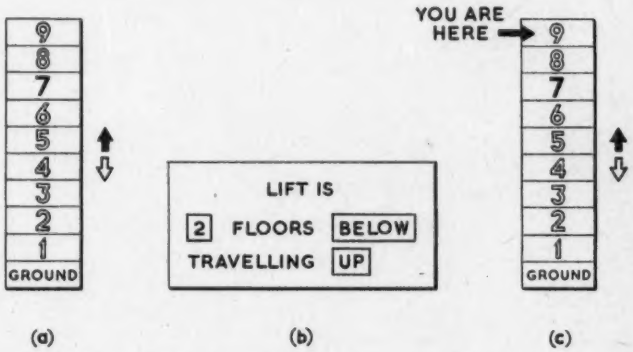


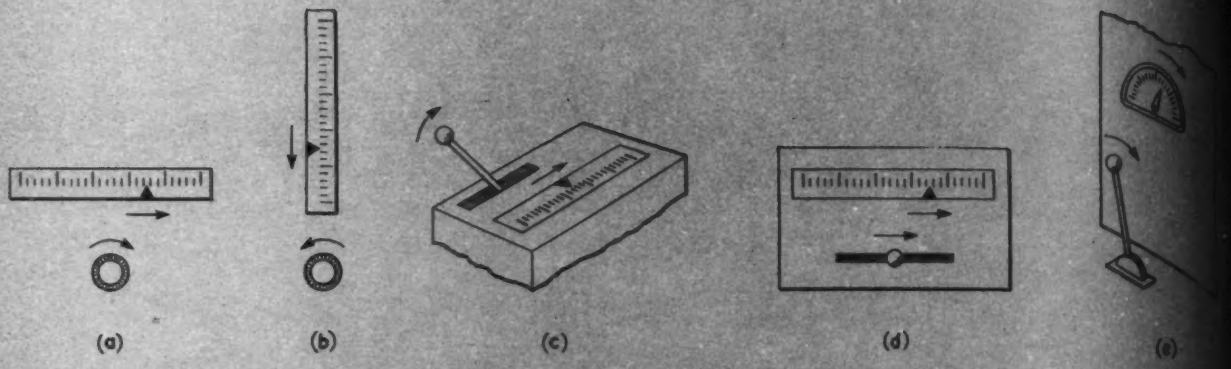
Fig. 3. Types of lift stage indicator giving the same information in different ways (the indications shown here are for a person waiting on the ninth floor). Objective reference is illustrated at (a), and subjective reference at (b). To give partial subjective reference information, (a) may be easily modified as in (c).

and representational indicators, and not with quantitative indicators, since these are by their very nature objective reference displays.

Design of the Quantitative Indicator

The quantitative indicator is the most extensively used in practice, and most research has been performed on this type, so that a great deal is known about the factors necessary for good design. Three types of quantitative indicator exist: (a) the fixed scale along which a pointer travels; (b) the moving scale which travels past a fixed pointer index or lubber line; and (c) the counter or digital read-out. Of these three, research has been concentrated mainly on the first, principally because it is the easiest to engineer.

In terms of effectiveness as an indicator, the choice entirely depends on the use that will be made of the indications. If the requirement is for absolutely accurate readings not involving more than about four digits, then the counter indicator is easily the best in terms of less errors, and time taken to make the observations. But if reasonable accuracy is needed with the additional requirement that changes shall be readily detectable during a swift glance, then the moving-pointer fixed-scale indicator is best. Special cases where the moving-scale fixed-pointer indicator gives the best answer are those involving non-linear scaling where the allowable error is a constant fraction of the scale range; and in the traditional compass-card, where the indicator combines a



Figs. 4 a to e. Illustrating five recommended control-movement/display-movement relationships.

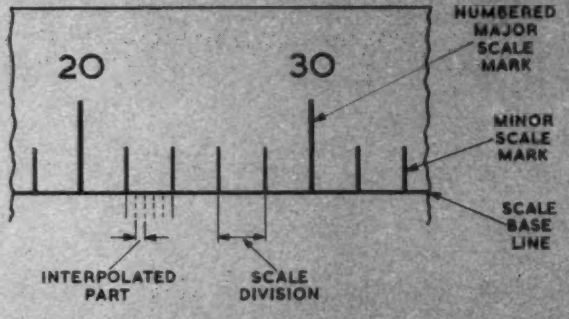
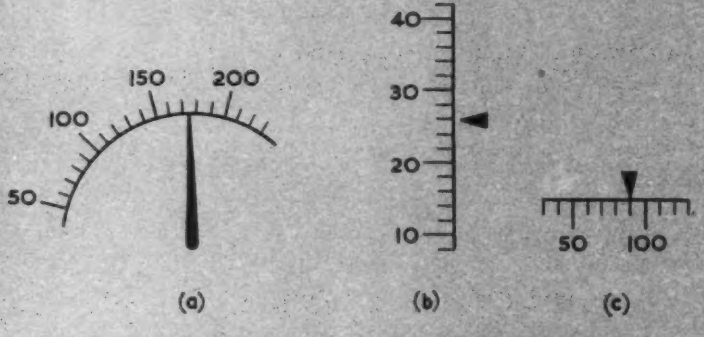


Fig. 5. Explaining the various terms used when discussing scale division. Note that the interpolated part is imaginary and only exists in the mind of the scale reader—in this particular diagram he is interpolating into fifths of a scale division.

Fig. 6. Does the observer report the reading here as 45 or 450?



Figs. 7 a to c. Three ideal scale-number pointer relationships. On Circular scales of more than 180° angular extent, method (a) is not practicable if the maximum scale length is required for a given panel area—in this case the numbers must be placed inside the scale.

INTERPOLATING A SCALE DIVISION INTO:—	ACCURACY
1) QUARTERS	±1%
2) FIFTHS	±1%
3) QUARTERS	±1·25%
4) QUARTERS	±0·83%
5) FIFTHS	±0·83%
6) FIFTHS	±1%

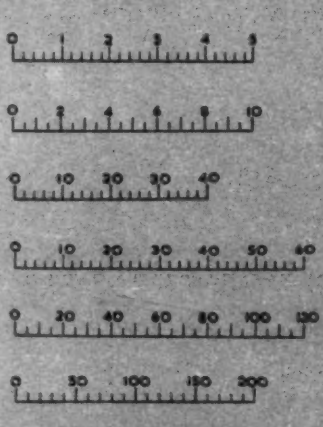


Fig. 8 i to v (*above*). Five examples of digit design: (i) British Standard recommended series for instruments[1]; (ii) Granby Bold type; (iii) Mackworth (designed for oblique viewing); (iv) Berger[2] (for U.S. car licence plates); and (v) Lansdell (intended to facilitate absolute recognition under extreme poor visual conditions).

[1]*Reproduced by permission of the Director, British Standards Institution.*

[2]*The use of these digits is subject to copyright.*

Fig. 9 (*left*). Examples of scales giving ±1% of maximum scale value (m.s.v.). Additional ranges can be provided as follows: (a) 0-50 and 0-100 can be derived from scales 1 and 2 respectively by adding 0 after scale numbers; (b) 0-12 and 0-20 can be derived from scales 5 and 6 respectively by omitting 0; (c) 0-30 can be derived from scale 4 by dividing the scale numbers by two; (d) 0-80 can be derived from scale 5 by terminating the scale at 80 (accuracy is then ±1·25% of m.s.v.). The accuracies are unaltered for cases (a), (b) and (c).

quantitative and a representational function. Thus the most suitable indicator to use can only be decided when the nature of the observations has been settled. There is however a common application where additional consideration has to be given to the direction of movement of the moving elements of the indicator. This occurs where a control is directly coupled to the variable indicated, so that control changes affect the indications more or less immediately.

It has been proved that people instinctively move controls in certain directions to produce specified indicator changes. Several studies of this type of behaviour have been made on Western populations, and the results are shown in Fig. 4. It appears that when rapid and error-free responses must be made, it is best to arrange the planes of movement of the indicator moving element and the control handle or knob, so that they are parallel. When the control and display movement planes are different, mistakes are more likely to occur. When the planes of movement are parallel, the directions of movement of the indicator element should be the same as those of the control to which the indicator responds. It is possible that control compatibility can be carried a stage further by adopting the principle that where the indicator element change is angular, then the control change should be angular also, and where the indicator change is translatory then the control should be translatory—thus the indicator "mimics" the control changes made. No experimental evidence appears to exist yet on this point, but it seems a reasonable concept to adopt when one considers that rotatory and translatory motions are distinctly different in "quality" in normal human experience.

The control indicator relationships described apply to fixed-scale moving-pointer indicators. Obviously, with counter designs there is much less freedom of choice in this respect, and an appreciation of the rate of change is more difficult for the user to achieve when he is trying to change rapidly from one value to another. Consequently, counters attached to controls are not recommended where rapid and error-free control is necessary. A further difficulty is that there is an inherent conflict between the direction of movement of the counter drums and the direction in which the numbers are printed on the drums. Because the counter is really a specialised form of moving-scale indicator, the same incompatibility occurs in even more acute form with the latter. In the absence of direct evidence it would seem safer to preserve the movement relationship at the expense of numbering direction.

Design of the Quantitative Fixed-scale Indicator

The most important features of design can be listed as: (a) scale length; (b) scale division and number sequence; (c) scale colouring arrangement; (d) dimensioning of scale marks, digits and legend; (e) pointer requirements; and (f) additional subsidiary features. These points are discussed in what follows.

Scale Length

Scale length is determined by two major factors: the distance of observation in normal use, and the accuracy to which readings are most often taken. The first of these presents no difficulty, since it is a matter of physical lay-out, and is usually easily decided. The second is often a compromise decision, since high accuracy requires a long scale, and the space and cost of these must be balanced against the cost of a given frequency of observations expected to be in error by more than the required tolerance when a less accurate scale is employed.

The important point to remember when considering requirements of accuracy is that some observations will always occur which are outside the allowable limits. A reasonable design target is that not more than 5 per cent of any random series of observations taken by experienced observers shall lie outside the chosen accuracy limits.

The accuracy of scale readings is based on the underlying assumption that the average observer is capable of resolving a given length of scale into a number of minimal parts (see Fig. 5). The physical size of these parts, expressed as an angular subtense at the eye, is constant over most of the normal range of observation distances. Hence if a scale capable of being read to within ± 1 per cent of its length is to be designed, it must be long enough to contain one hundred resolvable parts; and proportionately for other accuracies. However it is not sufficient just to quote a value for this constant, because scale reading is more than a purely visual judgment, and such a specification would suggest that provided the projected scale length accommodated the right number of parts then all would be well. This performance cannot be achieved unless the scale marking system is optimal. And of course the scale marking is tied in with the numbering system adopted, which in its turn is fixed by the desired indicated scale range. Consequently the design problem is to select the accuracy required, regard this initially as determining the scale length, and then select a scale maximum value (assuming the scale starts at 0) for which the minimal part will represent a suitable sub-multiple of the maximum scale value and yet allow a simple number system to be used.

Of course, it is possible to design larger scales than those suggested here, but the gain in performance will probably not justify the increased space and cost. As a round figure, the scale length should be $\frac{7}{4}$ in. long for each ft. of observation distance if the accuracy requirement is ± 1 per cent of the maximum scale value. This figure assumes (a) optimal scaling; (b) reasonable illumination level (15 equivalent foot-candles or better) on white parts of the indicator dial; and (c) 2 sec. being available in which to observe the indicator and make the most accurate reading possible.

Scale Division and Number Sequence

As mentioned above, the achievement of a specified accuracy of observation is very much a function of the scale dividing and numbering system provided. In fact if the smallest unit to which the scale should be read is not a simple sub-multiple of the scale maximum value, then the design will be bad. This means that the number of possible scale ranges is limited.

From all the experimental investigations that have been made, it is possible to suggest limits to the number of scale marks that lead to optimum performance. Most of the evidence is derived from experiments with curved scales—either quadrant, three-quarter or full circle. The extent to which the findings listed below will apply to straight scales is open to question, but if differences exist it is almost certain that they will apply only to the desirable number of numbered major marks that can be provided. On straight scales, particularly the vertically arranged ones, it may well be possible to increase the number of numbered major marks without creating the undesirable crowding which would occur on circular scales of more than 180° angular range. The optimum number of interpolated parts included within one scale division, and the optimum number of scale divisions included between adjacent pairs of numbered major marks, are extremely unlikely to be different for straight as compared to circular scales.

The optimum scaling system is one that: (a) requires the user to interpolate the small scale divisions into two, five or four parts; (b) possesses two, four or five scale divisions between adjacent pairs of numbered major marks; (c) possesses five, six or seven major marks with numbers; and (d) avoids the use of unnumbered major marks, except in cases where the number system makes an interpretation

of their value unambiguous.

In the same way the evidence makes it possible to suggest number sequences which give rise to the fewest errors. These should be restricted to one of the following: (a) 0, 1, 2, 3, etc., and in multiples of 10 or 100; (b) 0, 2, 4, 6, etc., and in multiples of 10 or 100; (c) 0, 5, 10, 15, etc., and in multiples of 10 or 100; (d) contains not more than three digits except for the terminal number—the third and if possible the second digits should be 0's; (e) avoids the use of decimal fractions; and (f) if a multiplying factor has to be applied to the indicated reading, it must be visible at the normal observation distance and be completely unambiguous (see Fig. 6). Examples of scales conforming as nearly as possible to these requirements are given in Fig. 9.

Scale Colouring Arrangement

This is perfectly straightforward. The aim is to achieve maximum brightness contrast between the scale marks and their background. All the dimensions suggested in this article are based on the assumption that a matt black and matt white colour arrangement is used. If colour arrangements giving reduced contrast between markings and their ground are employed, then dimensioning must be increased to suit. Experimental trials would be necessary to verify the increases chosen.

Whether white on black, or black on white is used seems to be largely a question of taste at normal brightnesses. At low brightnesses the evidence points to an advantage in using white markings on a black background.

Dimensioning of Scale Marks, Digits and Legend

In most cases dimensions are not critical, as long as the small scale division marks are clearly visible at the observation distance. Neither does the evidence make it possible to specify the optimum ratio of dimensions between major and minor marks. Excessively long scale marks push numbers into the centre of circular scales, or force the scale in from the edge of the visible surface of the dial. The important point is to proportion the two types of scale marks so that they are easily distinguishable, otherwise it is difficult to locate numbers against their scale marks with certainty. A length increase of 50 per cent, combined with a thickness increase of 25 per cent, for major scale marks over minor scale marks provides discrimination. A reasonable starting point for dimensioning is to allow one thirty-second of an in. per ft. of observation distance for the length, and 0·005 in. per ft. for the thickness of major scale marks.

Considerably more knowledge exists about the characteristics of easily visible digits and letters. But before listing these characteristics one point should be made about the general form or shaping of digits. Easy recognition of digits is to some extent a function of familiarity with the shapes. It is however possible to design digits (see Figs. 8iv and v) which are very rarely confused with one another under extremely difficult conditions of observation, but which have an unfamiliar appearance to the untrained observer. Since these special designs are often intended for observation under conditions very different from normal indicator reading conditions in industry, care should be exercised before applying them to indicator numbering. The bonus of familiarity is one not to be lightly thrown aside.

Suitable digits and letters for indicators: (a) employ a bold modern form (see Figs. 8i and ii); (b) are not more than 50 per cent taller than their width—but height can be reduced to equal the width with no loss of visibility; (c) have a stroke thickness suited to the colour arrangement used; black characters on a white ground should have a stroke thickness of between one-fifth and one-tenth of the character height—the reverse colour scheme requires these values to be reduced to between one-eighth and one-fifteenth; and (d) the height should be about 0·03 in. for each ft. of viewing distance; larger sizes are acceptable, but cause number crowding on circular scales; also, to avoid "swamping" the scale surrounding the numbers, any increase in the above value should not be more than about 25 per cent (digit sizes for counter indicators are discussed below).

It will be obvious that all digits should be arranged in an upright position. The only exception to this occurs with circular moving-scale indicators, in which case the digits should appear upright in the viewing window. The spacing between adjacent digits in a group is usually specified by the designer of the digits.

Pointer Requirements

There is little research on this aspect of indicator design, but from the findings that do exist the following points can be made:

1. The pointer tip should coincide with the ends of minor scale marks. A tolerance of ± 50 per cent of the length of a minor scale mark is satisfactory if the pointer tip is no wider than the minor scale mark width.

2. It is immaterial whether the pointer is parallel-sided or taper-sided.

3. Pointer width is not critical. Obviously it should be at least equal in average width to the stroke thickness of a digit, and not more than three or four times this thickness if excessive number masking is to be avoided.

4. No visible tail should exist on circular scales if 180° reading errors are to be avoided.

5. Parallax between the pointer and its scale should be minimised. Since all indicators should be placed so that the line of sight of the observer is normal to the scale plane, this is unlikely to be a serious cause of error for the class of indicator being considered.

6. Wherever possible the pointer should be on the opposite side of the scale to the numbers. Fig. 7 illustrates preferable relations between scale marks and their pointer.

Additional Subsidiary Features

A few points not covered previously can be mentioned under this heading:

The first is the colouring and size of the bezel, which should never be too prominent. It should act like a picture frame—draw the eye to the picture without detracting from it.

A second and obvious point is that the dial face should contain the absolute minimum of irrelevent information for the observer. All maintenance and installation details necessary should be in small print, preferably in a colour of low contrast to the dial face, and placed in an "unused" corner of the dial face. Information of this sort can be read at leisure and close to the indicator.

The presence or absence of tramlines or a single scale base line is frequently the subject of debate. Unfortunately published evidence does not allow a decision to be made with any certainty. The writer's opinion on this problem favours the single base line because tramlines tend to mask the small scale divisions, while the total absence of a scale base line robs a scale of its unity.

In general, double scales are confusing to read, particularly under stress. Either one scale should be subordinated to the other by being made smaller and less conspicuous at the normal reading distance (although readable when close to the indicator), or a movable scale mask should be used (e.g. the Weston Master exposure meter for photographic use). The latter method is the better one to adopt when both scales have equal priority but are used in mutually exclusive conditions. The improved appearance amply repays the small extra design trouble.

Indicator cover glasses should be flat. Convex covers cause inescapable reflections, as anyone driving in sunshine behind a car with a wrap-around rear window will have noticed.

(To be concluded next month.)

RESEARCH AND DEVELOPMENT IN MATERIALS

AN illuminating report (PB 161,865) from the Office of U.S. Defence and Engineering is entitled "Summary of Recommendations for Research and Development in Materials". This document constitutes a review of the many recommendations that have been brought to the attention of the Department, and is derived mainly from specific studies by sub-committees and panels. Much of the work discussed is already being actively supported.

Iron and Steel

Regarding iron and steel, the recommendations call for an increased emphasis on high strength materials, particularly in the environments of low temperature and induced high temperature. An increase in the strength of steel castings of dependable properties is also required, and in this connection a new method of treating steel by working the metal in the metastable austenite range improves both its strength and resistance to crack propagation. Increasing the strength of all steels not subjected to brittle fracture to 300,000 p.s.i. would make possible a 10 to 20% reduction in the weight of aircraft landing gear, and it is suggested that it would thus be possible to produce a propeller-driven aircraft for speeds above Mach 2. In the case of high-strength steel suitable for use at elevated temperatures, the recommendations call for efforts to resolve problems in stress, corrosion, heat-treatment, embrittlement, corrosion prevention, coatings, notch toughness, and cold forming ductility.

The successful use of ferritic steels at low temperatures depends largely on welded construction. Therefore both the base metal and the weld metal must be of adequate notch toughness, and the former should not be impaired by the thermal effects of welding. This may require the development of new electrodes or techniques.

Refractory Metals

Major problems in research on refractory metals can be divided into basic and applied research. The nature of transition temperature behaviour and its fundamental causes should be determined. Very little is known at present about the high-temperature flow and fracture characteristics of these metals and their alloys, particularly under conditions of high strain rate. Tests should be carried out over a wide range of environmental conditions, especially in the temperature range above 1,100 deg. C., and adequate fatigue tests should be developed for composites which will not cause local failures at the points of loading. It is suggested that particular emphasis should be given to the study of tungsten. Rhenium is also regarded as a refractory metal deserving more intensive development, since it affords interesting possibilities for increased ductility as a weld filling metal and as an alloying additive.

Numerous recommendations for increased research on the basic properties and practical applications of graphite have been made, covering the development of manufacturing methods, protective coatings and non-destructive methods of testing. It has also been proposed that basic research should be undertaken on the production properties, potentialities and aggregation of graphite whiskers, and on the possibility of inter-planar bonding of graphite by the addition of other elements incorporated in the lattice. For systems requiring erosion resistant surfaces of refractory metals (e.g. tungsten), graphite is under development and should be continued to be studied. The bonding if graphite to these metals and to strong metallic backing surfaces also needs to be investigated.

The importance of structures capable of maintaining strength and integrity at elevated temperature has been recognised for ceramic materials, their restricted use in engineering applications being due to their brittleness. The results of research in ceramic materials have tended to be disappointing, but in view of the important potential of these materials it is suggested that the current level of research is inadequate. A marked increase in research on the inorganic chemistry of non-metallic solids, including the study of high-temperature reactions, phase equilibria, and structure is recommended.

Rare Metals

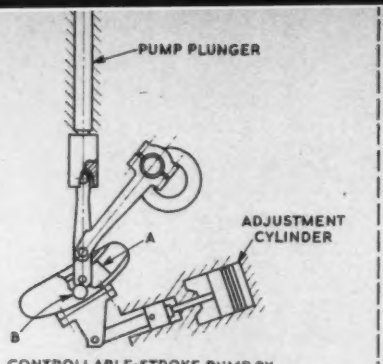
The rare earths have a great range of possible utility, and interesting metallurgical, chemical, thermal, electronic and atomic properties. These metals constitute an important section of the periodic table, and although they are abundant in the natural state their properties remain largely in question. Theoretically these metals and their compounds show promise in dispersion hardening systems. Moreover the techniques for handling reactive metals have been greatly enhanced by the extensive work carried out with metals such as titanium, zirconium and uranium. It is recommended that further investigations be carried out on the scavenging ability of these elements, and on the use of their oxides as precision polishing compounds for optical glass.

Plastics

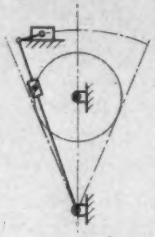
Regarding plastics, no organic fluids, elastomers and plastics are at present available to meet extreme conditions of high temperatures and radiation, nor can these materials be developed with existing knowledge. Entirely new approaches to the problem, i.e. inorganic polymers, will be required, and further studies are needed on adhesion between polymers and fillers, especially at high temperatures. The availability of textile material is limited where temperatures between 315 and 1,370 deg. C. are anticipated, and there is little data on fine metal filaments or their uses in fabrics.

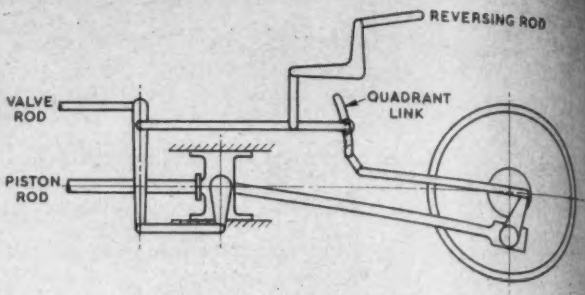
Many students of materials research programmes have a strong conviction that the development of ultra pure materials is one of the most promising approaches to the improvement of material properties, and it has been suggested that facilities should be established for the preparation of single crystals having experimentally useful dimensions, very carefully characterised purity, and perfection of structure.

The various concepts of composite materials include the binding of high modulus fibres with a plastics or ductile matrix, or with sheet laminate as a binder. The incorporation of fine discrete particles in a metallic matrix should be considered separately. Very little design data regarding the behaviour of materials in sandwich or other forms of composite structure is available. This is an important aspect, largely in the field of aeronautical engineering. In some applications no single material has adequate properties. Accordingly, new combinations of materials should be investigated and conventional combinations improved and exploited.



CONTROLLABLE-STROKE PUMP BY THE ALDRICH Co. Pa. U.S.A.

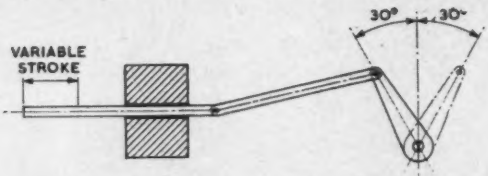

SHAPER MECHANISM



WALSCHAERTS GEAR

PROBLEMS IN DESIGN

Problem No. 19 (May): In a special-purpose machine a reciprocating lever causes a sliding member to move to and fro. As the angular reciprocation of the lever cannot be varied, adjustment of the length of stroke of the sliding member is difficult. Although this can be accomplished by slotting the lever, thus

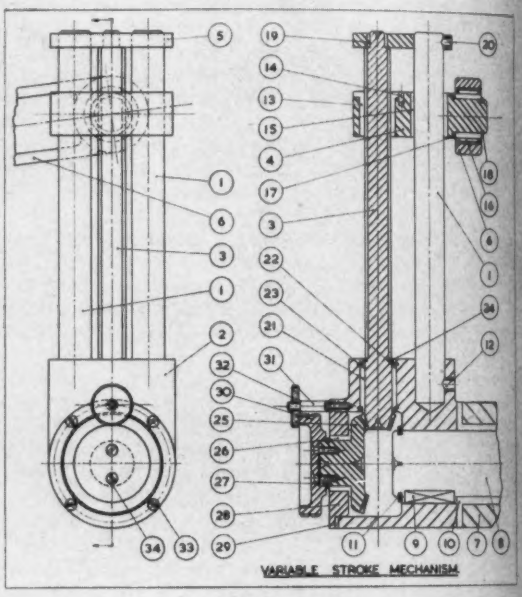


making the connecting rod pivot point adjustable and giving longer or shorter strokes, the operation of making the adjustment involves stopping the machine.

Suggest an alternative linkage which will enable adjustment of the stroke length to be carried out while the machine is running.

The problem of varying the amplitude of reciprocation of a sliding machine element is frequently encountered in engineering, and much ingenuity by engineers and inventors has resulted in a number of well-known mechanisms. A common example of such a mechanism is found in the variable stroke pump. The guide *A*, moving about the centre *B*, can be tipped to various slopes by the adjustment cylinder and its accompanying links. If the path for *A* is tipped to a steeper position, the plunger has a greater stroke and pumps more fluid. A somewhat similar mechanism, though rather more elaborate, is encountered in the Walschaerts steam locomotive valve gear, which enables the length of time the valve remains open at each end of the piston stroke to be varied, thus determining the amount of steam admitted to the cylinder. Then there is the mechanism commonly encountered in machine-shop shapers for varying the stroke length, which also embodies the Whitworth "quick return" feature. The above examples are only a few of the many which could be cited.

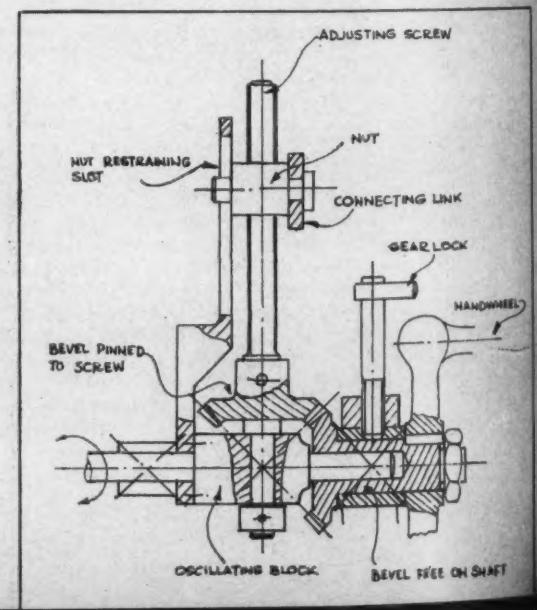
The problem produced such a large number of entries that it has been impossible to select more than a few examples of each kind while leaving out a large number of equal merit. In the kind of entry of which the largest number were received various ways of altering the crank arm length, without altering the main geometry of the linkage, were put forward. The ways of doing this, however, differed greatly in detail. **D. J. M. Drew** used a flexible shaft, operated by a knurled knob, to wind the crank pin back and forth in the slotted lever. **E. Clayton's** entry used a Bowden cable, passing through the pivotal axis of the lever and then through 90° and along the

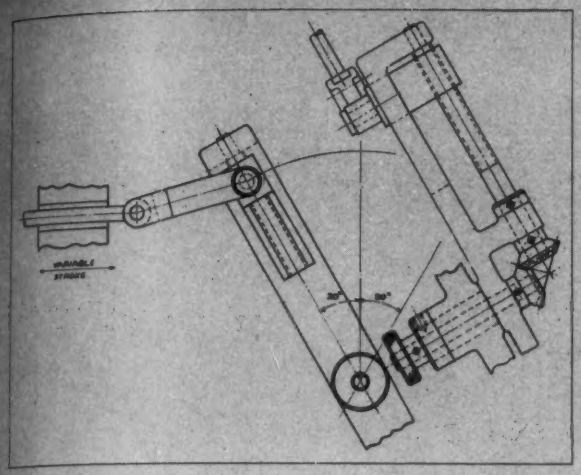


VARIABLE STROKE MECHANISM

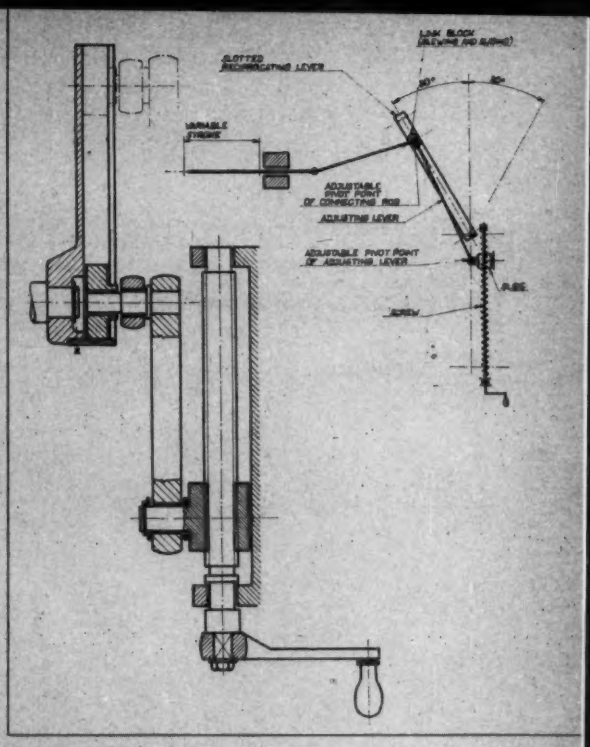
M. L. S. FLINT

J. ISAACS

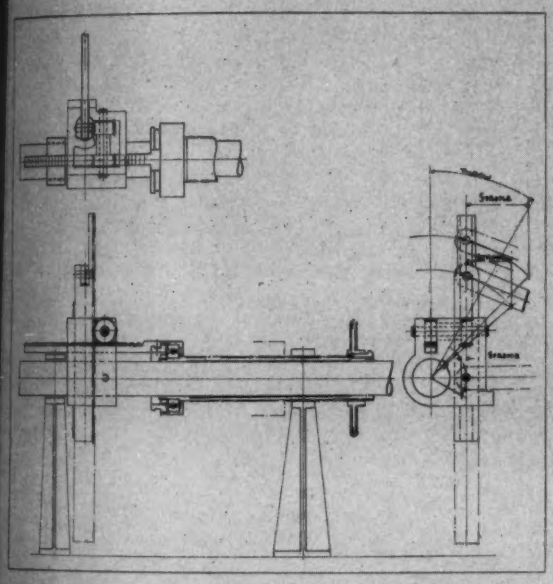




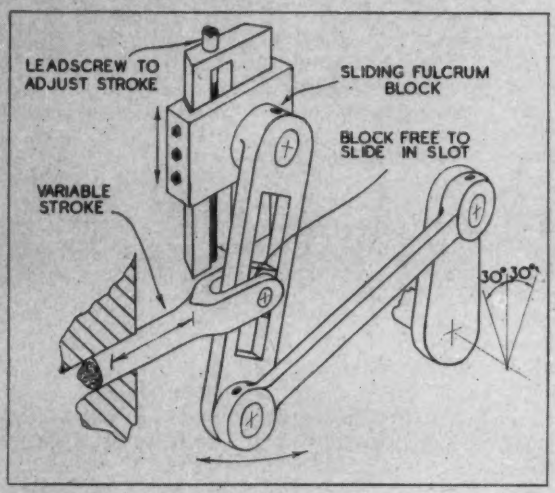
J. B. SMITH



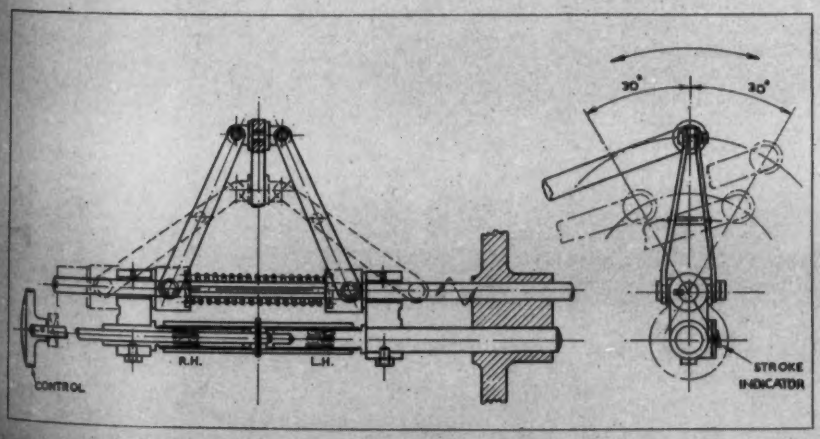
B. MAJOROS



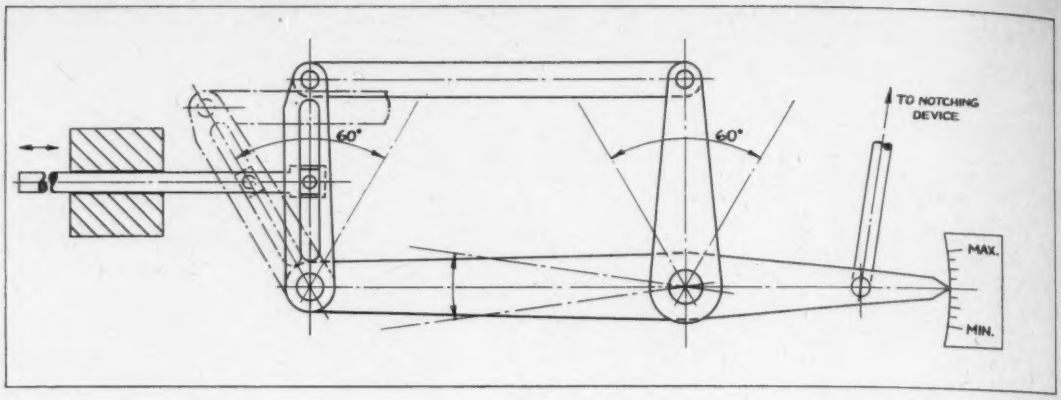
J. DODDS



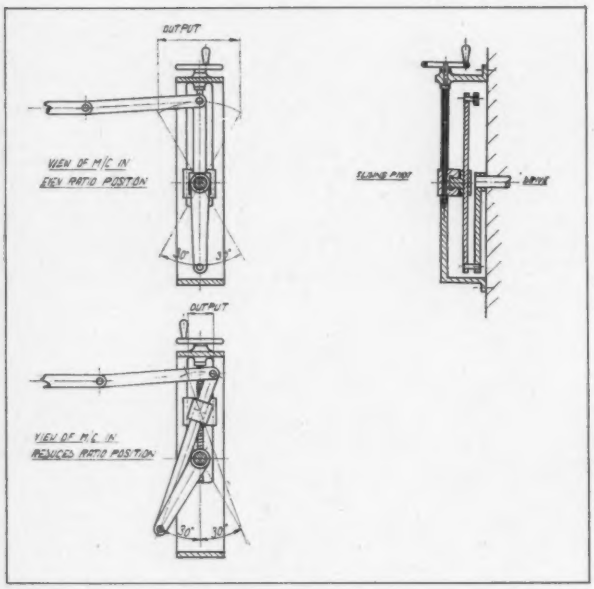
H. R. HOLLIDAY



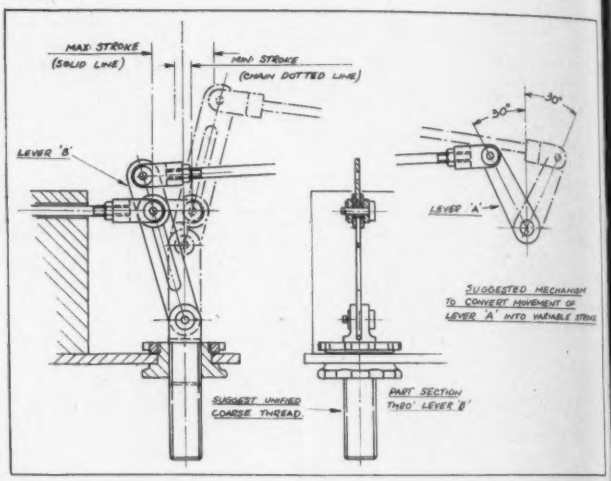
T. A. HENSHAW



J. M. FISKE

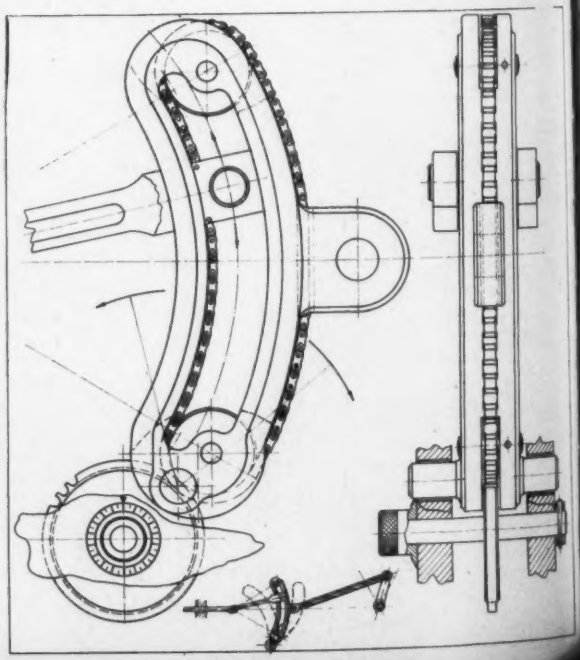


N. LOCKWOOD



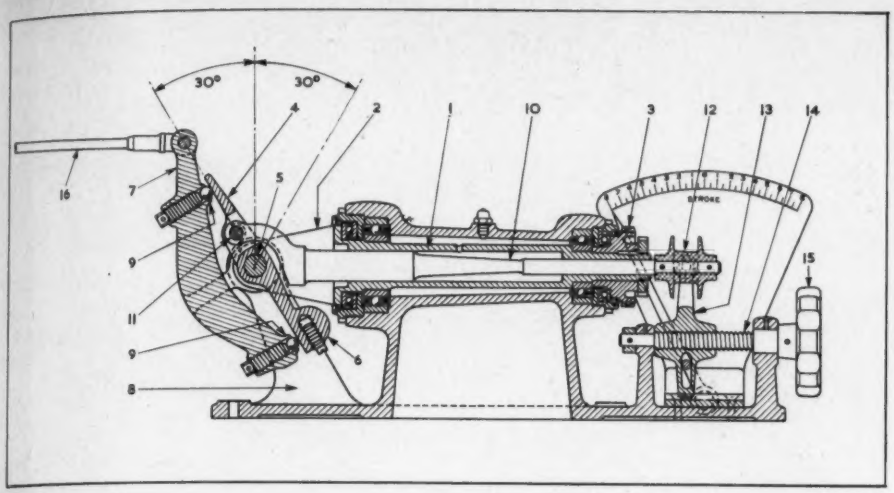
A. R. DIVEY

M. M. GRUBNER



length of the lever, to bring about the same result against the restraining force of a compression spring. Both of these ideas could only be considered for slow speeds and light duty. **M. L. S. Flint, J. Isaacs** and **J. B. Smith** all modified the lever so as to incorporate a bevel gear to enable the crank pin to be screwed up and down by a hand wheel mounted coaxially with the pivot of the lever. Mr. Isaacs' version prevented reciprocation of the adjusting wheel by keeping the bevel stationary and allowing slight movement of the crank pin. Grasping a knurled knob which is reciprocating at high speed could be a tricky operation, even if the movement were only 60°.

Although rather unnecessarily elaborate for the application the entries from **T. A. Henshaw** and **J. Dodds** show ingenuity in the way in which they adjust the crank length. In Mr. Henshaw's entry a control knob is used to bring together and draw apart the base elements of an essentially triangular link structure and so alter its height. The knob operates a right and left hand screw. Mr. Dodd's entry uses the kind of screw, rack and gear mechanism found in large boring machines for advancing the quill. Rotation of a handwheel, fitted to a screwed sleeve, advances a



C. W. TINSON

cylindrical member to which a rack is fitted. The rack causes rotation of a pinion, a second pinion on the same shaft causing the lever arm to be increased or decreased in length. This, of course, provides a fine positive adjustment, but would only be considered for a mechanism of large size.

The next type of entry brings about stroke length adjustment by a separate screw-operated lever, and the entry from **B. Majoros,** of Budapest, Hungary, is typical. It is, in our view, sound, the only slightly carping criticism to be made being that a small degree of extra sliding friction is introduced at the adjustable pivot point. Although engineered rather differently, the entries from **H. Y. Anstee, J. F. Jackson, H. Howarth** and **D. R. Harvey** were on similar lines.

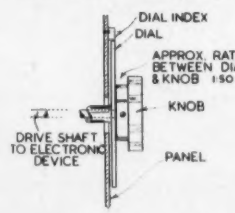
By interposing a second pivoted lever between the reciprocating lever and the slider, **H. R. Holliday, A. R. Divey** and **J. M. Fiske** all introduced the sliding adjustable element at a point where it would cause a slight bending moment in the output slider and so give rise to wear. Only correct proportioning of the output slider bearings would eliminate this. **N. Lockwood's** entry constitutes a partial kinematic inversion of the entry from B. Majoros. **E. Almoslino** submitted a line drawing which showed the geometry of a mechanism of the same kind.

The remaining two entries are quite different in conception. **M. M. Grubner,** of Haifa, Israel, employs an interesting variant of the principle employed in the variable delivery pump mentioned earlier. To bring about angular movement of the arcuate-slotted member he employs a most ingenious principle. Adjustment of stroke length is effected by the partial rotation of a knurled knob to which a sprocket is fitted. The sprocket engages a chain which passes round toothless pulleys at each end of the slotted member, and is attached at each of its ends to the slider. As the pivot point of the slotted member is on the pitch line of the chain, no movement of the slider will occur unless the adjustment knob is turned.

Clifford W. Tinson's entry radically departs from the requirements of the problem, rejects what is postulated, namely a reciprocating lever, etc., and then takes as the point of departure the input power source. Although Mr. Tinson has, in our view, "begged the question" in this way, we feel that our readers will be interested in his solution. A hollow shaft *1*, provided with a fork *2* at one end, is driven by a motor through a gear wheel *3* keyed to its other end. Articulated in the fork end is a swash plate *4*, the plane containing its face passing through the centre of the pin *5* about which it oscillates. A counterweight *6* is for providing dynamic balance.

A lever *7* is provided with straddle bearing arms to enable it to swing, on pins mounted in brackets *8*, about an axis passing exactly through the central point of pin *5*. The lever incorporates socketed balls *9* which make contact with the face of the swash plate. Within the hollow shaft is a rod *10* which, being pinned through slotted jaws on the swash plate at *11*, rotates together with the shaft, but can be moved axially by a bobbin and yoke mechanism (items *13* and *14*). A handwheel *15* operates the screw *14*. A pointer operated by the yoke gives a clear indication on a graduated scale of the smallest adjustment made to the stroke length without stopping the machine. We feel that readers should take note of the admirable proportioning of the various elements of this unusual mechanism.

PROBLEM IN DESIGN No. 23
Here is this month's problem



It is necessary to provide a more open scale at mid scale on an instrument dial by a mechanical method. Devise a drive between the dial and output shaft so that during rotation the following is performed:
0°-180° **dial rotation:** ratio of dial to output shaft rotation to increase from 1:1 to 3:1 approximately.
180°-360° **dial rotation:** ratio of dial to output shaft rotation to decrease from 3:1 back to 1:1.
The dial is to have a positive drive to the output shaft so as to maintain setting accuracy.

Problem contributed by **H. R. Holliday.**

Best solutions to "Problems in Design" are published and paid for. Send your solution for this month, with a drawing or diagram (in Indian ink and not more than 12 × 12 in., please!) to the Editor, "Problems in Design No. 23 (September)". Closing date October 20.

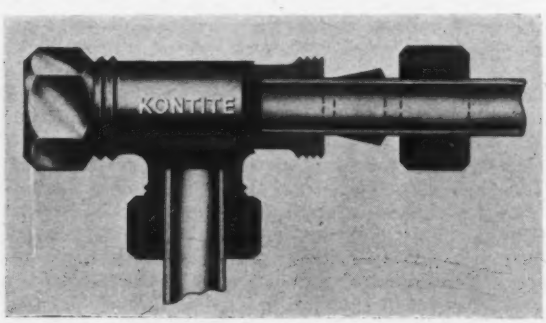
SCREWED UNIONS (cont.)

Kay & Co. (Engineers) Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Compression type: Kontite to BS 864 type A (non manipulative)	Gas Steam Petrol Water Oil	*Gunmetal* and *Brass* 200 150 100 75 75 50	 RT RT 93 93 121 121	Nominal pipe size: $\frac{1}{4}$ to 2 in. $2\frac{1}{2}$ in. $\frac{1}{4}$ to 2 in. $2\frac{1}{2}$ in. $\frac{1}{4}$ to 2 in. $2\frac{1}{2}$ in.
Kontite to BS 864 type B (manipulative)	Gas Steam Petrol Water Oil	*Gunmetal* and *Brass* 200 100 75 (Pressures refer to water. For other media the manufacturer should be consulted.)	RT 93 121	$\frac{1}{4}$ to 2 in.

Robert Harlow & Son Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Screwed type Compression type (manipulative)	Hydraulic Steam Air	*Gunmetal* and *Steel* *Brass* up to $\frac{3}{4}$ in. o.d. *Gunmetal* above $\frac{3}{4}$ in. o.d. (Compression types for pressures up to 120 p.s.i.)	—	$\frac{1}{8}$ to 3 in. BSP Nominal bore of pipe: $\frac{1}{4}$ to 2 in.

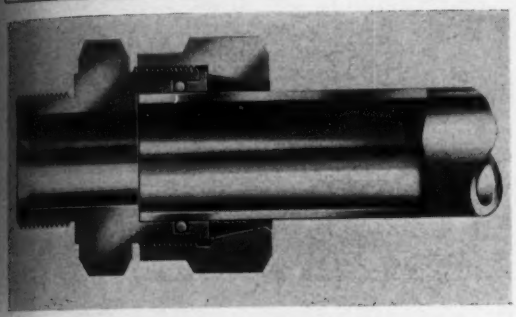


Keelavite Hydraulics Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Compression type: Keelatite (manipulative) (see Fig. 5, Aug.)	Hydraulic	*Steel* 7,000 5,000	−40 to +130	o.d. of pipe: $\frac{3}{16}$ to $1\frac{1}{2}$ in. $1\frac{1}{2}$ to 2 in.

Hydraulics Ltd. (cont.)

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Keelaring (non-manipulative)	Hydraulic	7,500	−40 to +130	$\frac{3}{16}$ to 1$\frac{1}{4}$ in. 1$\frac{1}{2}$ to 2 in. (For the custom-built flange-fitting version of Keelaring up to 10 in. o.d., see "Flanges for metal pipes")

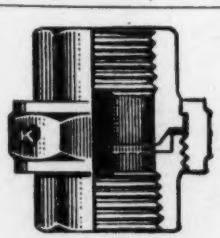


Kings Langley Engineering Co.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Compression type: Kingsley to BS 864 type B (see Fig. 2, August)	Water, Gas, Petrol, Oil, Steam	*Brass* 200	RT	Nominal pipe size: $\frac{1}{4}$ to 2 in.
		150		2$\frac{1}{2}$ in.
		100	93	$\frac{1}{4}$ to 2 in.
		75		2$\frac{1}{2}$ in.
		75	121	$\frac{1}{4}$ to 2 in.
		50		2$\frac{1}{2}$ in.

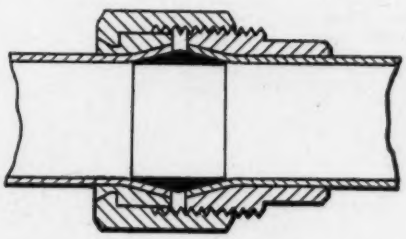
Kirk & Co. (Tubes) Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Screwed type to BS 1256	Steam, Water, Gas, Oil	*Malleable Iron* Water 200 Gas, oil and steam 150	—	$\frac{1}{8}$ to 2 in. BSP and API 2$\frac{1}{2}$ to 4 in. BSP and API



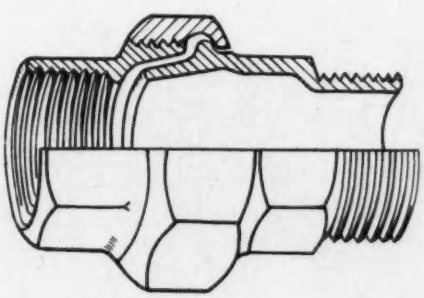
James H. Lamont & Co. Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Compression type: Securex to BS 864, type B (manipulative)	Water, Gas, Petrol, Steam	*Brass* 200	RT	Nominal pipe size: $\frac{1}{4}$ to 2 in.
		Gunmetal 150	RT	2$\frac{1}{2}$ in.
		100	93	$\frac{1}{4}$ to 2 in.
		75		2$\frac{1}{2}$ in.
		75	121	$\frac{1}{4}$ to 2 in.
		50		2$\frac{1}{2}$ in.



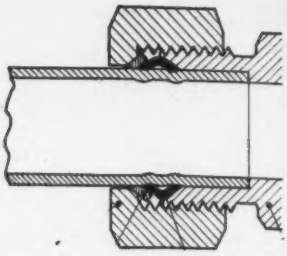
Le Bas Tube Co. Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Screwed types: G.F. fittings	Steam, Water, Gas, Oil	*Malleable Iron* Water at 200 Gas, oil and steam at 150	—	$\frac{1}{8}$ to 2 in. BSP (flat seat)
			—	$\frac{1}{8}$ to 4 in. BSP (conical seat)
Mac Union	Steam, Water, Gas, Oil	*Malleable Iron* Water at 200. Gas, oil and steam at 150	—	$\frac{1}{8}$ to 3 in. BSP (will tolerate 6° misalignment)
			—	



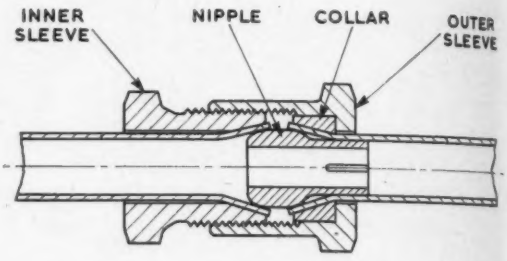
Maxam Power Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Compression type: (non-manipulative)	Air	*Brass*	—	o.d. of pipe: $\frac{3}{16}$ to 1 in.



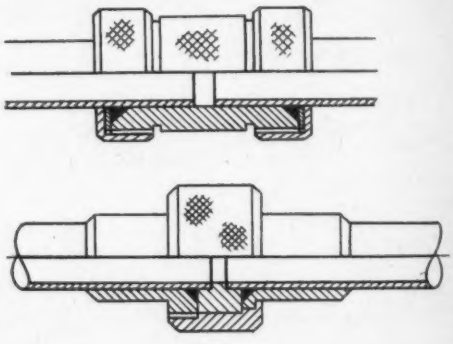
M.L. Aviation Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Type I	Hydraulic or Gas	4,000	−60 to +250	Pipe sizes: $\frac{3}{16}$ in. o.d. to $\frac{1}{2}$ in. o.d. utilising flared ends



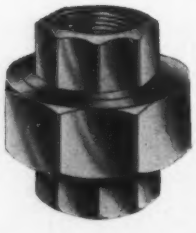
N.G.N. Electrical Ltd.

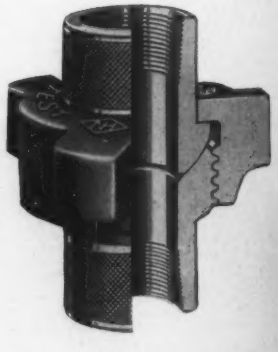
Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Screwed Type: Solderless Tube-to-tube union	Vacuum	—	—	Nominal bore of pipe: $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$ and 2 in. (to suit copper pipe to BS 659)
		—	—	



Newman Hender & Co. Ltd.

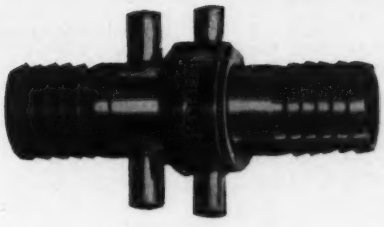
Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Unions (octagonal type)	Fuel oil Steam	*Steel* 3,000 C.W.P.	—	$\frac{1}{8}$ to 2 in. BSP (T), API thread or socket weld
Handle-bar unions	Water Oil Gas	*Steel* 3,000	—	1 to 4 in. API or BSP (T) threads
(Acme thread)		3,000 C.W.P.		
(Fitted with O-ring)		5,000 C.W.P.	—	1 to 4 in. API or BSP (T) threads





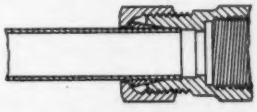
Newton Sales Co. Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Hercules hose couplings	Air Gas	*Brass* *Gunmetal* *Stainless Steel*	—	¼ to 4 in. BSP 1¼ to 4 in. BSP (To order)

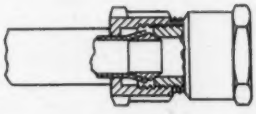


Peglers Ltd.

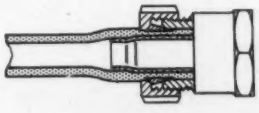
Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Compression type: Prestex to BS 864 type A (non manipulative)	Water Gas Petrol Oil Steam	*Brass* 200 100 75 *Gunmetal* 200 100 75	 RT 93 121 RT 93 121	Nominal pipe size: ¼ to 2 in. copper tube to BS 659 ⅛, ⅜ and 1 in. copper tube to BS 659
BS 864 type B (manipulative)		*Brass* and *Gunmetal* 200 100 75	 RT 93 121	½ to 1 in. copper tube to BS 1386



WITH BS 659 TUBE



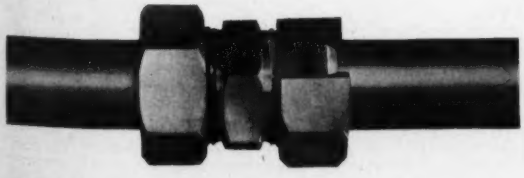
WITH BS 1386 TUBE



WITH BS 1972 TUBE

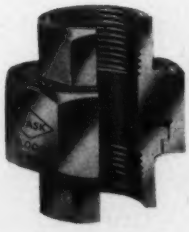
Simplifix Couplings Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Compression type: BS 2051, Pt. 1 (non manipulative)	Water Gas Air Oil	*Brass, Steel, Stainless Steel and Aluminium Alloy* Hydraulic 3,000 P'umatic 1,000 Hydraulic 2,000 P'umatic 600 Hydraulic 1,500 P'umatic 400 Hydraulic 1,000 P'umatic 250	 — — — —	o.d. of pipe: ⅛ to $\frac{5}{16}$ in. ⅜ to $\frac{7}{16}$ in. ½ to ¾ in. ⅞ to 1 in.



Walter Slingsby & Co. Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Screwed types: Wask	Oil Water Steam Gas Air	*Steel* 3,000 900	 RT 510	⅛ to 4 in. BSP (T) or API threads
Bronte Worth Aire		*Malleable Iron* 600 300 400 200	RT saturated steam RT saturated steam	¼ to 3 in. BSP (T) or API 4 in. BSP (T) or API



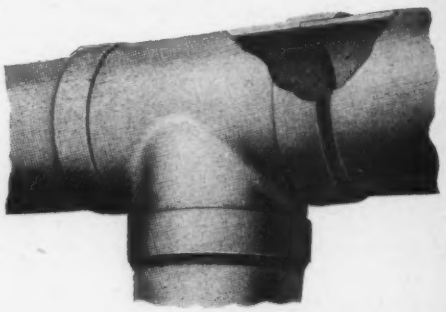
Yorkshire Imperial Metals Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Compression type: Instantor to BS 864 (non manipulative) (see Fig. 3, August)	Water Oil Gas Steam	*Gunmetal* and *Brass* 200	RT	Nominal pipe size: ¼ to 2 in.
Kuterlite (as Instantor, but lighter in weight)		100 75 150 50	93 121 RT 121	½ to 1½ in.
Coneor to BS 864 (manipulative)	Water Gas	*Gunmetal* 200 100 75	RT 93 121	½ to 1½ in.

WELDED, BRAZED, SOLDERED AND CAPILLARY JOINTS

Donald Brown Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Welded	Water	*Brazing alloy* 200 100 75	RT 93 121	¼ to 2 in. nominal bore.



Compression Joints Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Tex capillary type	Water LP steam	*Brass* 1,500	121	¼ to 2 in. nominal bore. (copper tube to BS 659).

The Mint (Birmingham) Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Capillary to BS 864	Water Gas	*Copper* 200 100 75	 RT 93 121	Nominal pipe size: ¼ to 2 in.

Johnson Matthey & Co. Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
	—	—	—	Method of jointing copper pipes by high-strength low-temperature silver brazing without couplings.

Yorkshire Imperial Metals Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Yorkshire	Water Oil Gas Steam	*Brass alloy, copper or gunmetal.* 200 100 75	 RT 93 121	Nominal pipe size: ¼ to 2 in. for brass, part of this range in copper.
Capillary, to to BS 864		150 50	RT 121	2½ in. brass or gunmetal.

FLANGES FOR METAL PIPES

Belle Asbestos and Engineering Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
To BS 10, tables F, H, K and R	Steam	*Bronze* and *steel* up to 600 steam pressure	—	Nominal pipe size: ¼ to 12 in.

Donald Brown Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
To BS 864, type B	Air Water LP steam Hydraulic	*Gunmetal* compression type —	— —	2½ to 6 in. o.d. pipe to BS 659.
To BS 10, tables D, E, F and H	Steam	*Gunmetal* screwed or plain for brazing up to 450	—	½ to 8 in. nominal pipe size.

Compression Joints Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Titex Senior	Water Gas LP steam	*Brass* compression type 150	RT	Nominal pipe size: 3 and 4 in. (copper tube to BS 659).

Conex Terna Ltd.

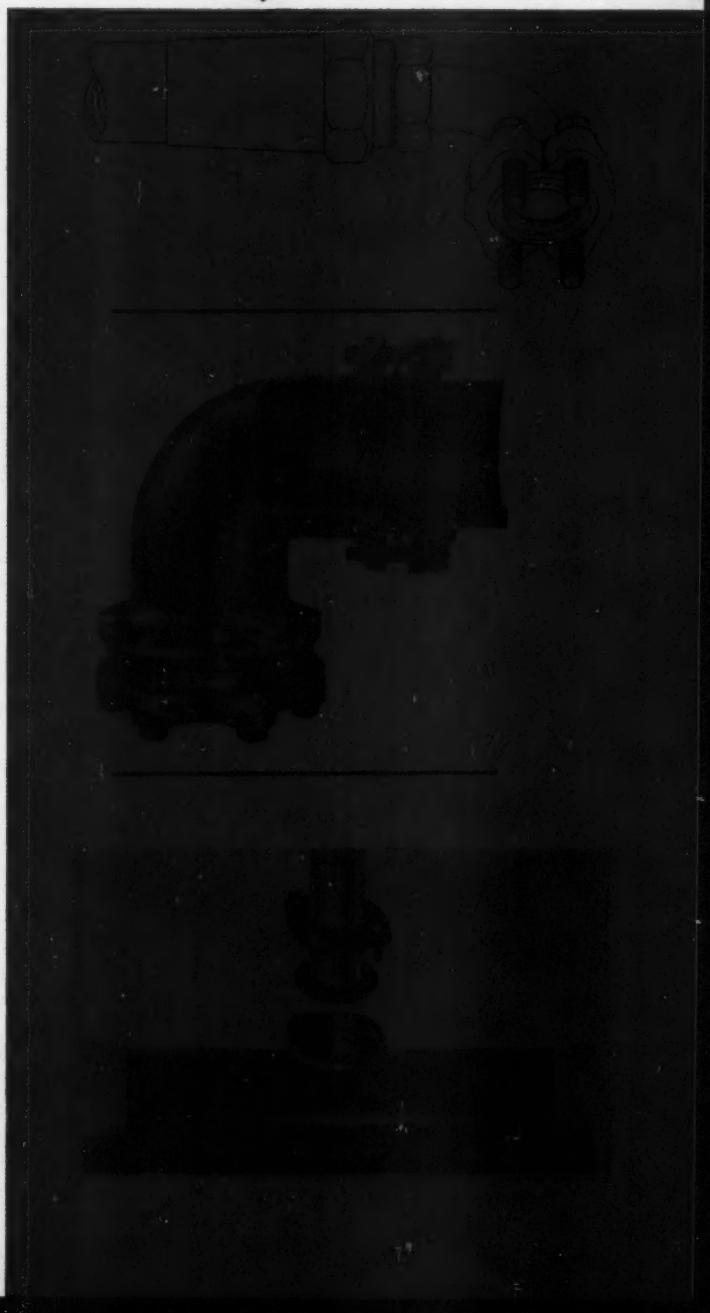
Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
BS 864, type A	Water	*Brass* compression type 150 75 50	RT 93 121	Nominal pipe size: 2 to 4 in.

Federated Foundries Ltd.

Suitable for *cast iron* soil pipes, 2 to 6 in. stack size. The FF joint is a patented fast fix joint which is a development of the bossed type of fitting. It can be used in place of bosses, and does not require a union or adaptor in making branch joints. It is also available in place of the standard socket for 3½ and 4 in. branches, thus dispensing with the caulked joint.

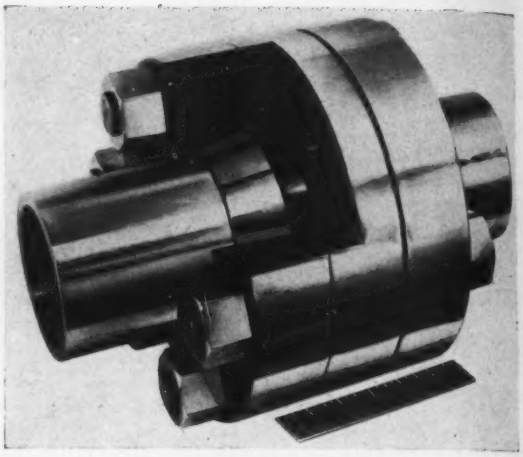
BTR Industries

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Re-usable or swaged Hi-flex hose couplings	Hydraulic Air Fuel oil Lubricant Coolant	*Steel* split flange, 5,000 to 1,000	—30 to +110	¼ to 2 in. hose bore.
Fulflex	Chemicals Abrasives Liquids	*Duralumin*, *malleable iron* and *manganese bronze* —	— —	Nominal bore 1 to 16 in.



Kay & Co. (Engineers) Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
	Water Gas Steam Petrol Oil	*Brass* and *Gunmetal* compression flanges to BS specification —	— —	Nominal pipe size: 3 to 6 in.

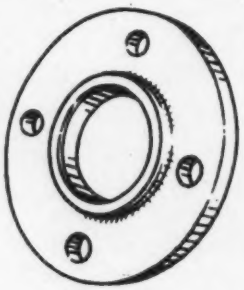


Keelavite Hydraulics Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Keelaring King Size	Hydraulic	5,000	—40 to +130	Custom-built flange fitting up to 10 in. o.d.

Kings Langley Engineering Co. Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Kingley Senior	Steam Water Gas Oil Petrol	*Brass* compression *Brazing alloy* Screwed (gas thread)		Nominal pipe size: 2½ to 4 in. ¼ to 6 in. to BS 18, table D. ¼ to 6 in.

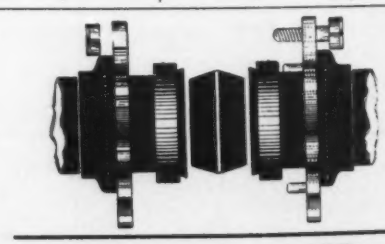


Kirk & Co. (Tubes) Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
	Steam Water Gas Oil	*Steel* and *stainless steel* 2,500	— —	Nominal pipe size: ¼ to 48 in.

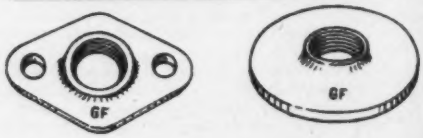
James H. Lamont & Co. Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Securex	Water Gas Petrol Steam	*Brass* and *gunmetal* compression-type fitting —	— —	Nominal pipe size: 3 to 6 in.



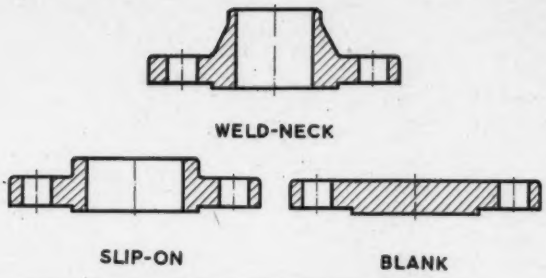
Le Bas Tube Co. Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
	Water Gas Oil Steam	*Malleable iron* oval flanges round flanges —	— — —	¼ to 4 in. BSP.



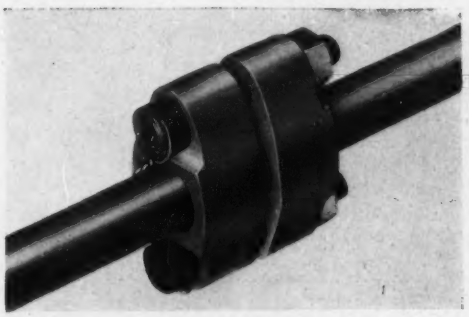
Marston Excelsior Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
	Ducting for industrial plant	*Aluminium* alloy weld neck, slip-on and blank flanges equivalent to BS 1560	—	Nominal pipe size: ¼ to 24 in.



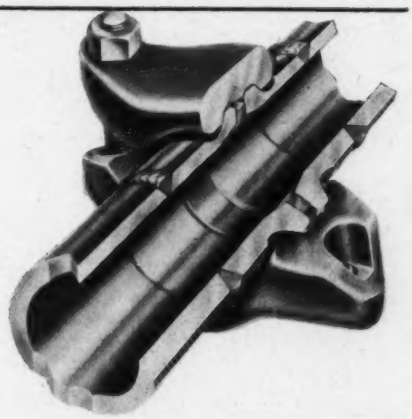
M.L. Aviation Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Type 2	Hydraulic Gas	4,000	—60 to +110	Lightweight joints. Suitable for pipe sizes $\frac{3}{8}$ to ½ in. o.d. utilizing flared ends.



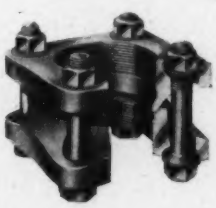
Ruston & Hornsby Ltd.

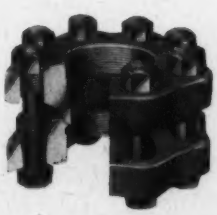
Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Grayloc	Pressure Vacuum	4,250	350	Nominal bore ¼ to 1½ in. 1½ to 30 in.



Walter Slingsby & Co. Ltd.

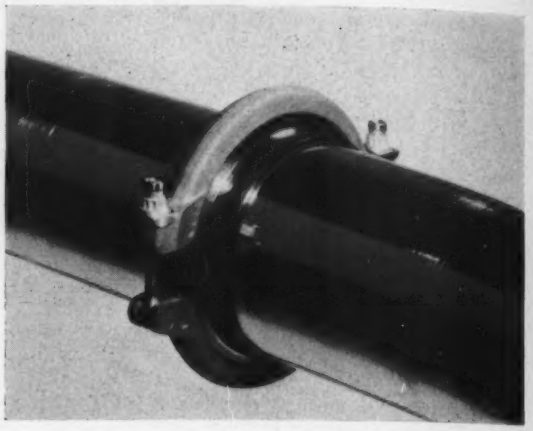
Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Navo	Water Oil Gas Air	*Malleable cast iron* with *copper* or *iron* spherical seats		Nominal pipe size: (BSP(T) or API).
		1,000		2 in.
		800		2½, 3 and 4 in.
		600	RT	6 in.
		500		8 in.
		250		10 and 12 in.
Keelee	Oil Water Gas Air Steam	800	RT	1 to 4 in.
		300 with steam		
		500	RT	5 and 6 in.
		250 with steam		
		400	RT	8 in.
		200 with steam		
Aero	Oil Water Gas Air	*Malleable cast iron* with *copper* seat		
		2,000	RT	¼ to 4 in.





Avica Equipment Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature °(C.)	Remarks
	Air Gas	*Stainless steel* V flange coupling		o.d. of pipe:
		400	500	1 to 1¼ in.
		300	500	1⅜ to 3½ in.
		200	500	4 and 4½ in.
		100	500	5 and 6 in.

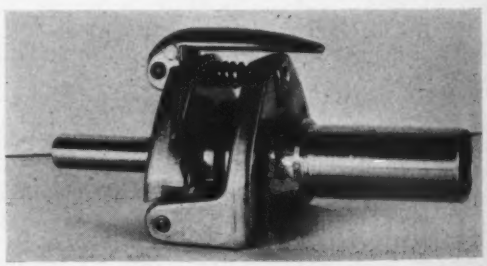


Avimo Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
MK 10/1/187	Water Liquids	Self-sealing quick-release bayonet type in *stainless steel* 150	RT	7/16 in. bore.
MK 1/1/50		Self-sealing quick-release bayonet type in *stainless steel* 50	−20 to +70	½ in. bore.

Appleby & Ireland Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
	Vacuum	*Stainless steel* quick-release coupling. Leak tightness to 10^{-9} atmospheres/cm.^{3}/sec.		10, 20 and 30 mm. o.d.



B.E.N. Patents Ltd.

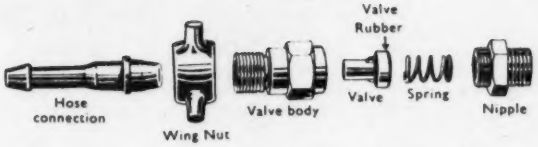
Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Instantair	Air	Quick-release self-sealing bayonet-type hose coupling, *mild steel* 90 (Pressure tested)	66	¼ and ⅜ B.S.P.

B.T.R. Industries Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Fulflex	Chemicals Abrasives Liquids	Toggle Clamp		

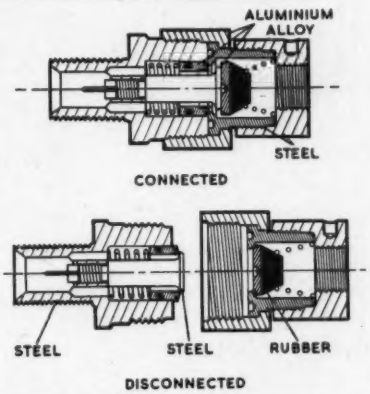
Consolidated Pneumatic Tool Co. Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Pick Automatic (screwed)	Air	Self-sealing, in steel 100	82	For ¼ and ⅜ in. hose.



Dowty Hydraulic Units Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
	Hydraulic	Self-sealing hand-tightening steel coupling 3,000	−40 to +90	¼ to 1 in. BSP
Tractaline		Self-sealing hand-tightening steel coupling 3,000	−40 to +90	⅜ in. BSP



Exactor Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
	Fuel oil Mineral oil	Suitable for hand coupling hoses 200	−40 to +200	1¼ to 12 in. bore
	Hydraulic oil Fuel oil Lubricants	Self-sealing couplings in *brass*, *steel* and *aluminium alloy* 3,000	−40 to +140	Flange or hose connections with either screw or rotary cam engagement, ¼ to 4 in. bore

Feeny & Johnson Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
	Pneumatic Steam Water	Quick-release with or without sealing valves 11,500 10,000 5,000 7,000		Special couplings to order ¼ in. BSP ⅜ in. BSP ½ in. BSP ¾ in. BSP

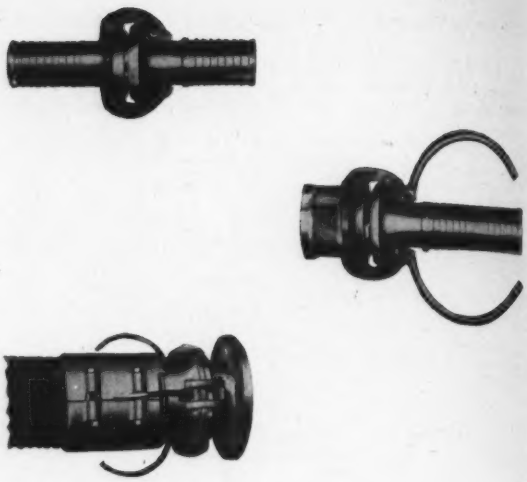
Flight Refuelling Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
F.R. self-sealing, for nuclear applications	Gas Vacuum	350	370	Nominal bore: ¾ and 2½ in.
F.R. ship-to-ship refuelling at sea (self-sealing)	Fuel oil	150	70	6 in.
Type 505 bulkhead	Fluids	75 (400 for special variant)	—	
F.R. quick-release hose	Fuel oil Petroleum products	1,500	70	4, 6, 8, 10 and 12 in.
F.R. quick-release swivel		1,500	70	6, 8, 10 and 12 in.

Type 505 bulkhead connection.

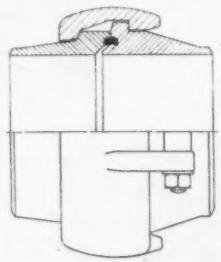
Gullick Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
	Petrol Steam Air Water	*Cast gunmetal*, quick- release coupling, lever action. 100	38 (Higher pressures to suit specific applications)	Hose bore: ½ to 7 in.
		Screwed Flanged —	—	2 to 4 in. BSP. 1 to 7 in. nominal pipe size (special sizes and threads to order)



General Descaling Co. Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
	Oil (pipelines)	*Steel*, bolted lug-flange closure 2,700	—	Nominal pipe size: 2 to 36 in., weld to pipe (see illustration). 2 to 10 in. internally threaded.



King Aircraft Corp.

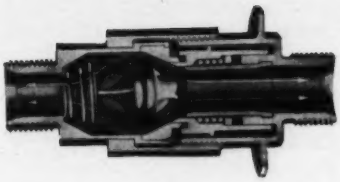
Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Aeroquip Series 5500	Refrigeration Air conditioning	*Steel* self-sealing coupling, screwed bulkhead mounting (braze to tube)	—	Tube o.d. 0·25 to 1 in.
Aeroquip Series 5400	Refrigeration Air conditioning	*Steel* self-sealing coupling, screwed bulkhead mounting 3,000	—	Tube o.d. ¼ to ⅞ in., 7/16 to 1 1/16 in. UNF, UNS
Aeroquip Series 5100	Hydraulic Gas	*Steel* self-sealing coupling, screwed wing or hexagonal nuts 3,000	—	⅛ to 1½ in. NPTF or BSP
Aeroquip Series 3200	Hydraulic (aircraft missiles)	*Steel* self-sealing coupling, screwed 3,000	−36 to +135	⅞ in. UNF, 1 1/16 to 1 7/8 in. UNS,

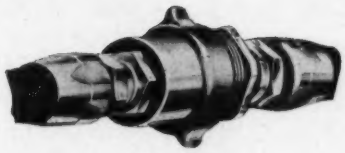
Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Aeroquip Series 5600	Hydraulic	*Steel* self-sealing quick-release coupling, push-pull type 3,000	−40 to +71	½ to 1 1/16 in. UNF, NPTF or BSP
Aeroquip Series 13473	Hydraulic Pneumatic	*Steel* self-sealing quick-release coupling, push-pull type, with clip to hose 3,000	—	Hose i.d. ⅜ to 1¼ in.
Conoseal, lightweight, medium, and heavy duty	Chemicals Oil Hydraulic Nuclear applications	V type flanges and clamp, suitable for welding to pipe in *stainless steel* or other materials 1,350	680	Tube o.d. 1 to 9 in.

The Aeroquip series are also available from Super Oil Seals & Gaskets Ltd.

Lockheed Precision Products

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Screw type	Hydraulic Oils Lubricants	3,000	−30 to +100	Standard range designed for DTD 585. Sizes $\frac{1}{4}$ to $1\frac{1}{2}$ in. BSP
Bayonet type	Hydraulic oils Lubricants Coolants	4,000 (High-temperature type +250)	−30 to +100	$\frac{1}{4}$ to $\frac{3}{4}$ in. Available in materials to suit type and service.
Hydralinc	Hydraulic oils	3,000	—	Tractor/trailer coupling, $\frac{3}{4}$ in. BSP female /$\frac{1}{2}$ in. BSP male.
Safelinc	Petrol Air	200	—	For connection between outboard motor and inboard fuel tank. Ideal for pneumatic tools. Connections for $\frac{3}{16}$ in. bore
L.P.G. type	Butane Propane	250	—	For liquefied petroleum gas tankers, and storage vessels. Sizes 1, $1\frac{1}{2}$ and 2 in.



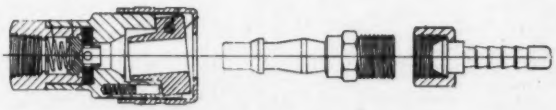


Matchless Machines Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
		O clip, pincer fastening hose to fitting 14,000 test pressure	—	o.d. of hose $\frac{1}{4}$ to $2\frac{3}{4}$ in.

Pneumatic Components Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Standard, heavy duty and Wee	Liquids Gases	Airline couplings, quick-release type 300	—	



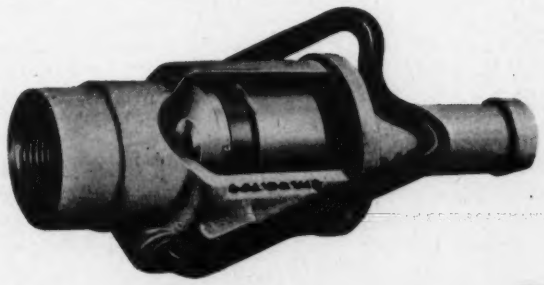
Power Auxiliaries Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Roylin 1000 series	Water Fuel oil Chemicals	Quick-release couplings in various materials, 6,600 (steel)		$\frac{1}{4}$ to 2 in. BSP(T) or fittings for hose and flared tubes

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
Roylin 1,300 series		Self-sealing, quick-release 300 connection pressure	—	$\frac{1}{4}$ to 2 in. BSP (T) or fittings for flared tubes

Victor Products (Wallsend) Ltd.

Type or Trade Name	Suitable for	Maximum Working Pressure (p.s.i.)	Maximum Working Temperature (°C.)	Remarks
	Air	Quick-connecting hose coupler with spring bridle 150	—	$\frac{1}{4}$, $\frac{3}{4}$ and 1 in. BSP or hose-to-hose fittings



POLYPROPYLENE — The Insulator of the Future

Although polypropylene has been commercially available in Britain for something over two years, comparatively little seems to have been heard of it yet in engineering. Here is a brief account of its nature and properties

by G. F. REDGRAVE*

POLYPROPYLENE is a thermoplastic polyolefin analogous to polythene, but polymerisation is brought about in the presence of an organo-metallic catalyst without the high pressures associated with the production of polythene. Depending on the conditions, two alternative forms of chain structure are produced, with a single carbon atom in each side chain. In one, the molecules are all arranged in regular order—this has been called the isotactic variety. In the other, which is known as the atactic type, the molecules unite in random fashion to produce a rubbery, non-crystalline polymer.

The isotactic form, however, is a stiff, crystalline substance having a melting point of 176 deg.C., which is some 30 deg.C. or so higher even than that of high density polythene. Its mechanical properties at around 100 deg.C. are equivalent to those of low density polythene at room temperature, and although its melting point is lower than that of nylon, its service temperature can be made nearly 50 per cent higher by the inclusion of an appropriate anti-oxidant, with only a limited effect on the power factor. It becomes brittle at about 0 deg.C., but down to –200deg.C. it possesses twice the impact strength of normal polystyrene; however, to ensure this, rather greater care than with polythene is necessary in design and the choice of moulding methods. In freedom from water absorption, and the excellence of its electrical properties it resembles polythene very closely, but it is chemically superior in its resistance to solvent attack and environmental stress cracking, while mechanically it has the advantage of a lower tendency to cold flow.

The physical properties of isotactic polypropylene can be varied considerably by controlling the crystalline structure, and the purity in terms of atactic content. The former influences the melt viscosity, impact strength, and stiffness, while the latter, by affecting the total available crystallinity, governs the maximum heat resistance, and rigidity. Pure isotactic polypropylene is slightly off-white in colour, being transparent in thin sections. It may be self-coloured by dry-colouring methods, which give a good dispersion. Although it is less affected by ultra-violet radiation than is polythene, it is nevertheless desirable to protect it against high radiation densities or prolonged exposure, where these are anticipated, by including a small percentage of carbon black filler. Unlike polythene there is little cross-linking under exposure to high-energy radiation; the chief effect is one of break-up of the chain structure, with a reduction in molecular weight, and deterioration in mechanical strength.

Fabrication by Injection Moulding

Polypropylene is readily fabricated by the injection moulding process, and a pressure of the same order as for linear polythene is required (about 20,000 p.s.i.), which is about twice that needed for the low density variety; this is because of the high viscosity, and the volume change on cooling. The optimum moulding temperature lies in the range 230 to 275 deg.C. With its high melting point around 170 deg.C., the melt remains quite viscous up to about 230 deg.C., at which point it begins to decrease steadily; after 275 deg.C., however, the rate of fall in viscosity becomes much greater, and it is preferable not to exceed 260 deg.C., therefore, in order to avoid local overheating. Good control of the temperature of the cylinder, and of the time cycle are necessary, for prolonged heating above the melting point leads to a decrease in the molecular weight, accompanied by a lowering of the viscosity; there is also a general deterioration in other properties. Another important difference between polythene and polypropylene is that the flow of the latter is much more responsive to shear, and higher injection speeds and ram pressures can therefore be used with advantage in filling complicated moulds, although the sizes and positions of the gates require careful attention.

Polypropylene is the lightest thermoplastic material at present commercially available, with a density of approximately 900 mgm./cc. This means that the shot capacity is low, the optimum value being about 60 per cent of the polystyrene rating, although the number of articles pro-

*Belling & Lee Ltd.

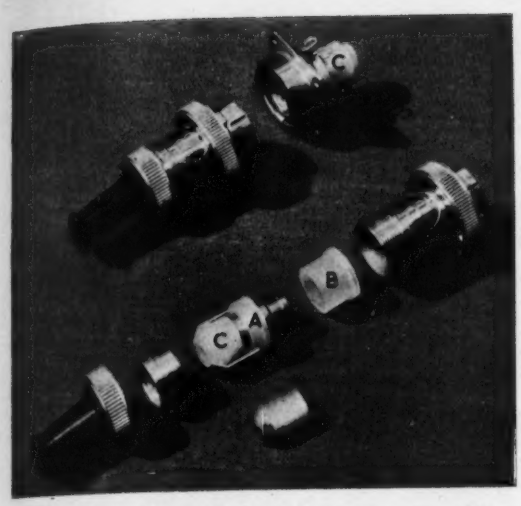


Fig. 1. Duax double-screened co-axial connector. The white plastics cap marked *C* is moulded from nylon at present, but is to be changed to polypropylene. The lower part of the picture shows the plug partly dismantled, the parts in polypropylene being marked *A* and *B*.

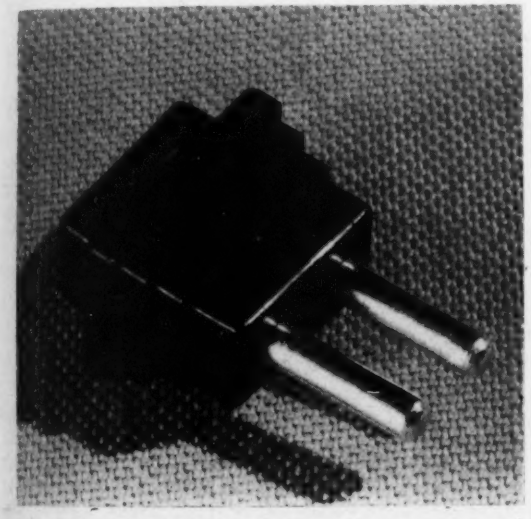


Fig. 2. Shorting link made of polypropylene. The two projecting pins are the ends of a U-shaped moulded-in insert.

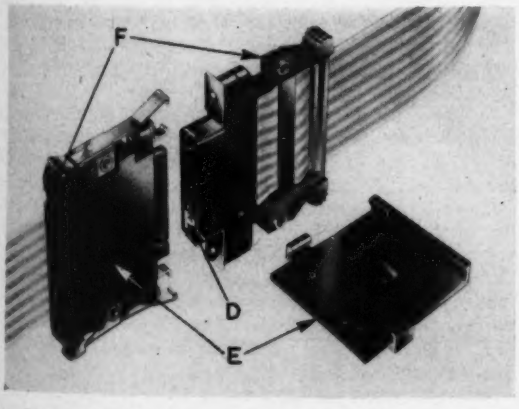


Fig. 3. Ribbon feeder connector, with *D* (polarising pin), *E* and *F* indicating the polypropylene parts.

duced per lb. of granules is correspondingly greater. The plasticising capacity is also lower, being about 70 per cent of that for polystyrene, although this is higher than for high density polythene. The mould shrinkage is less than that of polythene but higher than for polystyrene, being between 1 and 2 per cent, although the variation between in-line and across-flow shrinkages is less than for either, appreciably reducing the chances of obtaining distorted mouldings. A useful practical feature is that the cylinder can be cleansed easily by peeling—there is no burning out or dissolution required. In considerations of cost all these factors have to be taken into account, and with its low raw cost polypropylene is an attractive proposition economically.

The moulded product has a good surface finish and gloss, and the surface hardness is comparable to that of cellulose acetate and high impact polystyrene, with a better resistance to abrasion than the latter, although in this respect not quite as good as nylon. Its application to the production of electrical insulators is an obvious choice in the light of increasing demands for ever higher working temperatures, and in addition it offers useful advantages for operation at ordinary temperatures: over nylon, in respect of improved electrical properties in humid conditions; and over polythene, in the way of much greater resistance to stress cracking. However, the feature of polypropylene which will probably command the widest interest is that, due to its high melting point, high quality components employing this new material as the insulant to support metal inserts intended for soldered connections, e.g. co-axial plugs and sockets, are far less vulnerable to damage by prolonged application of the soldering iron.

Applications

A practical application for polypropylene in the field of electronic components is shown in the accompanying photograph of a double screened coaxial connector (see Fig. 1). Here polypropylene has superseded polystyrene as the material for the insulating ring and sleeve between the inner coaxial components and the outer shells. An electrical insulator was needed with, among other things, a good power factor, a reasonable working temperature range, and high strength. Polystyrene met these requirements well, although tending to be brittle; polypropylene is markedly superior in this respect, while satisfying all the other requirements.

Figs. 2 and 3 show typical applications of polypropylene in two new components, where this material is now the natural choice of insulant instead of nylon or polythene which would formerly have been used. In the case of the Shorting Link, the choice was one of sheer economics; almost any insulating material would actually have been satisfactory from the point of view of performance, since the requirements were not arduous. In the Ribbon Feeder Connector, however, where polypropylene is used for the case and cover, and also for the polarising peg between the socket contacts, an insulating material with a certain amount of resilience was necessary, for the cover is a snap-on fit, and the polarising peg has to be movable to any position and is therefore held in under compression. Nylon would not have been as satisfactory since it swells and contracts according to the moisture content, while the upper temperature limit of polythene was considered to be hardly adequate.

Incidentally, in this connector and its cable we have an interesting assortment of insulating materials. The socket moulding is a phenolic resin, chosen for its good electrical properties and mechanical stability; the contact assembly of the plug is a copper-clad laminate; and the cable is made up of a number of parallel copper foil strip conductors laid in polythene and covered overall with a film of polyester for extra mechanical strength.

KNOW YOUR METALS — IRON

A simple treatment of the subject of iron and steel for the junior designer who has not been trained in metallurgy, and an explanation of some of the puzzling technical terms in common use

by F. LISTER*

THE field of engineering is so large in variety and so complex in detail that the young engineer usually welcomes an abridged version of a subject which, although very important in itself, is far too involved for anyone other than a specialist in that particular field to know thoroughly. It is with this thought in mind that I have attempted in this article to give a brief coverage of iron and its treatment for the benefit of those who, while not requiring detailed knowledge of the physical properties of iron and steel, are at the same time involved in their usage.

I would like, therefore, to bring to your notice a few interesting details concerning the metals that many engineers serve their working hours in moulding and machining to a predetermined shape or size. Have you considered why one metal is harder, more ductile, or tougher in stress than other metals? Here in brief is a description of the factors which contribute largely to the properties of metal.

First of all here is a note on pig iron, which is a material of great importance in the foundry and in many steel-making processes. The raw materials used in its manufacture are: (a) ore, consisting of iron oxide or carbonate associated with impurities as derived from the earth; (b) limestone, which is a flux to combine with the non-worked portion of the ore in order to form a fluid slag; and (c) coke, to reduce the iron oxide to iron and to provide heat for melting the metal and slag.

These materials are charged into the furnace, and hot air is blown through injectors placed near the bottom of the furnace. The molten iron accumulates in the hearth with the slag floating on top of it; both are tapped periodically. The molten iron is transferred to steel furnaces, or cast into sand or chill moulds to make "pigs", which are usually 5 in. x 5 in. x 2 ft. in length. Incidentally, the main channels from the furnace to the troughs are termed "sows".

While in the blast furnace the iron absorbs carbon, silicon and sulphur, and the whole of the phosphorous in the charge. The iron produced is classed according to its phosphorous content, the low phosphorous (0·03 per cent) iron being made from red hematite ore.

Each class of pig iron can be graded according to the fracture, grey, mottled or white, which for a constant rate of cooling is largely dependent on the silicon content.

The crude iron as tapped from the blast furnace is rarely suitable for making castings without remoulding and refining. Consequently a mixture of pig iron, foundry scrap, limestone and coke is melted in a cupola, then tapped and run into sand moulds to give cast iron.

*Priestman Brothers Ltd.

Wrought Iron

In Britain wrought iron is made by the puddling process, which consists of melting grey pig iron and mill scale in a small coal-fired reverberatory furnace, the hearth being lined with iron oxides. The impurities in the pig iron react with the iron oxide to form a slag. The removal of silicon, manganese, phosphorous, and finally carbon, causes the freezing point of the metal in the furnace to rise until it is actually higher than the furnace temperature; thus the metal solidifies into a pasty mass of metal closely intermixed with considerable quantities of slag. These pasty balls are withdrawn, hammered and rolled into crude bars, which are then cut into lengths, piled together, heated to welding temperature, and rolled into suitable sections. This rolling, of course, serves to weld layers together, and to elongate the slag into fibres and thus promote greater uniformity throughout the section. This wrought iron possesses the property of recovering rapidly from overstrain; this enables it to accommodate sudden and excessive shocks without permanent injury.

Steels

Steels are usually composed of a very large percentage of iron, with small percentages of important "property-giving" metals or elements added in the furnaces. Carbon, silicon, nickel, manganese, chromium, sulphur, lead and aluminium are some of the better known ingredients which are added to improve the properties of the iron. It must be realised that a comparatively small increase or decrease in any of these elements will alter the whole structure of the steel, giving it entirely different physical properties. Table 1 shows how the properties of steel vary with different percentages of carbon.

Consider now the properties given by the addition of small amounts of other metals or elements: (a) the addition of nickel gives strength to steel; chromium is essential in the production of stainless steel; zinc gives a non-corrosive steel; and copper helps to make steel a good electrical conductor. Now try to imagine the results of small and varying amounts of two or more of these constituents being introduced to the iron or steel, and you will get an idea of the tremendous field covered by the study of iron and steel, ranging from high tensile steel with a breaking stress of 100 t.s.i., to malleable steel which may be forged to almost any desired shape without fracturing.

We must also consider another factor which has a very large influence on the steel, namely the melting and cooling during manufacture. Iron melts at about 1,540 deg. C.,

whereas the "property-giving" metals melt at much lower temperatures, so the addition of these other metals to the main iron is very complicated and requires the skill of a leading furnaceman.

Austenitic steel is a solid solution of carbon in gamma iron, and therefore is relatively soft and ductile; this steel is non-magnetic. Martensitic steel is one which has a very fine grain, and which contains carbon atomically dispersed but not in solid solution; martensitic steels are harder than austenitic, and are always magnetic.

Even when steel has left the foundry or rolling mill it can still be treated to give it further added properties, e.g. a hard-wearing surface may be required, as used for gear teeth or clutch faces, or steel may be required to have its hardness removed so that it may be more easily machined or worked. Or again, a component of some machine may have been overworked or stressed too severely; this component can have these stresses removed and its strength restored by various processes. Here are a few of the "treatments" used on steel:

Annealing is the heating of metal to a specific high temperature, followed by slow cooling in the furnace. This results in the removal of the effects of strain, normal crystalline structure or grain of the steel being restored. This strain is often caused by cold working during manufacture. Prolonged annealing tends to induce greater ductility, but at the same time reduces strength. This process is often used on steel sheets and wire, both of which have had to be well rolled during manufacture.

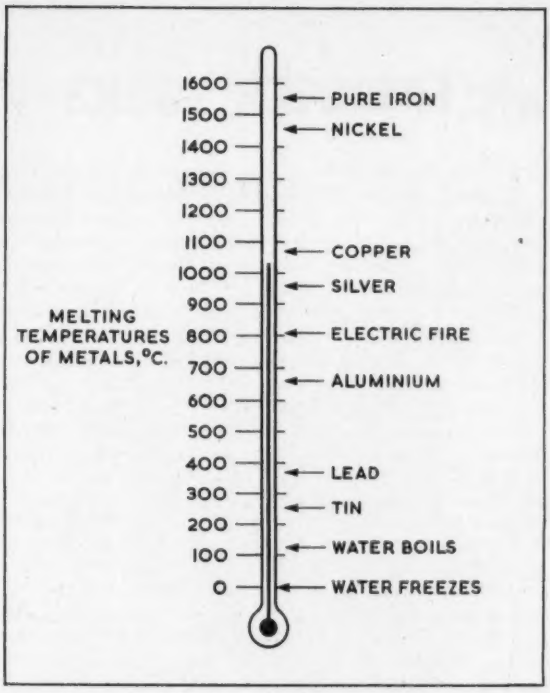
Normalising is the heat-treatment of steel by cooling it in air from a high temperature at a given rate. This treatment releases internal stresses and gives good structural formation of the metal. The differences in the results obtained by normalising as opposed to annealing vary considerably. For instance, the tensile strength of the yield point are greater with normalising. The thickness of the metal being treated can cause considerable variation in properties when using this process.

Nitriding is a process of using nitrogen to produce a hard case on the steel. This is done by treating steel with ammonia at 500 deg. C. The steel absorbs the nitrogen from the gas, and then cools to give a hard case on its surface.

Tempering. The martensitic part of quenched tool steel is very brittle and highly stressed. Thus cracking and general distortion often occur after quenching; to obviate this, the steel is tempered. This process consists of re-heating the hardened steel in an oil bath to a certain temperature, and then cooling it off, thus increasing its toughness.

Table 1. Showing the tremendous difference that a small amount of carbon makes to the strength and toughness of steel.

Carbon (%)	Steel suitable for:
0·05	Lifting chain
0·1	Food cans
0·2	Ships' side plates
0·25	Structural "sections"
0·4	Locomotive axles
0·55	Railway and tram lines
0·7	Woodworking chisels
0·8	Sewing needles
0·9	Circular-saw blades
1·0	Axe heads



Hardening consists of heating the steel to its normalising temperature and then cooling it fairly rapidly in a suitable medium, i.e. oil or water. Steels with less than 0·3 per cent carbon cannot be hardened effectively. The maximum advantages of hardening are gained on steels containing approximately 0·7 per cent carbon.

Water, which is cheap in Britain, is one of the most efficient media used commercially for quenching, but there are drawbacks to this, such as a liability to cause distortion and cracks. Where a lesser degree of hardness is required it is advisable to quench with oil (whale or mineral).

High strength steel is tough and ductile, but for maximum wear resistance steel must be hard and brittle. Thus, if we require a high strength component to be wear resistant, we are faced with a paradox. To overcome this, surface hardening is employed, wherein intense local heat is applied to the surface of the component, followed almost immediately by quenching with water and/or oil. A typical method is flame-hardening, or "Shorter-hardening" (named after its inventor Mr. A. E. Shorter, of Sheffield), in which an intensely hot oxyacetylene flame is moved across the surface of the part being treated, followed almost immediately by water jets which quench the heated areas, giving the hardest and most wear-resistant properties obtainable. The speed of the process ensures that the heat does not penetrate deeper than 0·1 in., so the toughness and ductility of the body of the material is unaffected. Recent developments use high-frequency induced electric currents instead of a flame, thus allowing greater control over the process.

Case-hardening is used where a tough casing is required over a malleable centre portion (usually mild steel with a maximum percentage of 0·2 carbon). The steel is packed in an air-tight box containing a carbonaceous material. The box is then heated to a high temperature, and allowed to cool freely in its own time. The metal may then require a further heat-treatment to suit it for special uses.

I hope this short essay has whetted your appetite for more knowledge of metals. If so, there are plenty of good books on the subject to be had from the public libraries. So don't forget—know your metals!

AN ENGINEER LOOKS AT THE SOVIET EXHIBITION

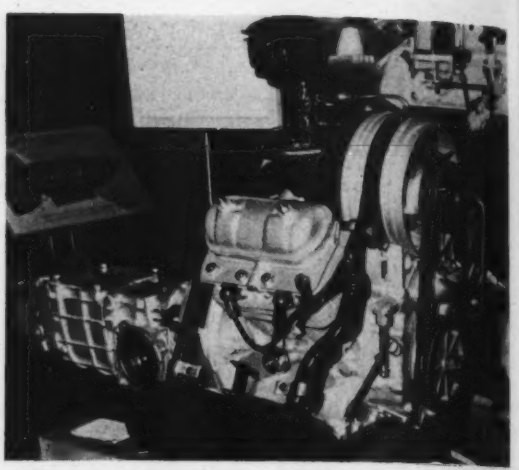
"LIKE the British Trade Fair in Moscow, the reciprocal Soviet Exhibition in London is a trade and industrial display"—so the official press hand-out stated. In fact, although the Exhibition provided a convincing overall picture of the tremendous advances in Soviet technology and industrial achievement in the last forty years, when considered as a display ground for Soviet engineering products it was exasperating. Any visitor hoping to make a technical assessment of a particular field was liable to frustration—technical information, either verbal or printed, was conspicuous by its sparsity. There was too a certain commercial naivety in the display of individual products that was not entirely unpleasing—an absence of the slicking-up process that is a feature of Western industrial exhibitions. Many of these machines and instruments had obviously been doing a job of work before they were dispatched to London.

Generally speaking, it was the large-scale projects shown in model form that were most interesting—constructional projects, hydroelectric power stations, automated steel melting shops and rolling mills, oil well drilling and processing installations, and coalmining equipment. In the latter field, an exhibit of particular interest was a crawler-mounted tunnelling machine, which has been purchased by the National Coal Board. The rotating cutting head, fitted with renewable picks arranged spirally over the head face, can sweep the heading in any desired direction, being actuated by vertical and horizontal hydraulic rams. The broken material is conveyed from the heading by a continuous chain conveyor. Another interesting coalmine exhibit was the OMKT system for the completely mechanised winning and conveying of coal, and for controlling the roof.

In transport, probably the most interesting exhibit was the so-called "midget" motorcar Zaporozheths ZAZ965—in fact, a reasonably roomy rear-engined four-seater with an 0.746 litre air-cooled V engine developing 23 h.p. Independent coil spring suspension is provided on all four wheels. The car weighs 1,440 lb., and at cruising speed the fuel consumption is 50 m.p.g. Top speed is 56 m.p.h., and turning circle diameter is 32.8 ft. Although not open to inspection, the front bonnet would appear to provide ample luggage accommodation; and, if the vehicle is used as a two-seater only, the back of the rear bench-type seat folds forward to give generous storage space for baggage. Lines and finish generally are neat and unpretentious.

On view only in model form were some of the passenger hydrofoil craft designed for regular and excursion service on Soviet inland waterways. Sputnik, the largest of the hydrofoil craft, has accommodation for 300 passengers and is driven by four 800 h.p. engines at a speed of 38 knots. Meteor, carrying 150 passengers and powered by two 850 h.p. engines, cruises slightly faster at 43 knots.

Agricultural engineering, very important to the Soviet Union, was well represented with a selection of the tractors, combine harvesters, mounted ploughs and grain drills that are in service today. The machine-tool section too was impressive, exhibits including a semi-automatic ultrasonic machine for drilling holes 0·05 to 4 mm. dia. in diamonds, carbides or ceramics; a jig borer with optical setting; an automatic turret lathe with punched-tape control of spindle speed, feed rate and sequencing of machine motions; and a heavy-duty digital programme-controlled multi-purpose machine for horizontal boring, drilling and milling, capable of handling workpieces of up to 2 tons. Other exhibits in this section included tools designed to hold removable pentagonal (and other multi-angular forms) carbide or ceramic tool tips, which can be turned to present a new cutting edge as wear occurs.



Air-cooled 23-h.p. engine of the Zaporozhets car.

Spark erosion equipment was featured not among the industrial machinery, but in the Science section, where there were pulse generators for spark-machining and for spark-plating with carbides, this process being used to harden cutting machine elements. Also shown were examples of spark-machined dies and fine-bore tubing, and a spark-hardened camshaft. A pamphlet issued by the U.S.S.R. Academy of Sciences gives some indication of their progress in this technique for machining ultra-hard metals, which they pioneered nearly twenty years ago. Today, they are using spark machining for "straight and curvilinear metal cutting; rough and precision machining at rates and with accuracies that cannot normally be obtained on conventional machine tools; making through and blind holes of intricate shape; and modifying the original properties of metal surfaces by introducing alloying elements." They have pulse generators operating with frequencies up to 500,000 pulses/sec.—it is not stated whether this is research equipment or whether it is developed to industrial standards. They claim that the maximum capacity of spark erosion machines reaches dozens of cubic centimetres, and that the surface finish is measured in fractions of a micron. Whether these fine finishes are achieved simultaneously with the maximum metal removal rate quoted is not explicit—experience in the United Kingdom suggests that this is unlikely, but clearly the Soviet Union are well advanced in this field.

Russia's magnificent achievements in space technology were depicted in a manner picturesque but uninformative; the Americans put across their space exploration achievements much more effectively at the recent Paris Aeronautical Salon. Another field in which the Russians are known to be highly advanced, thermonuclear research, was illustrated by models of a toroidal plasma chamber, and of the Ogra magnetic trap for accumulating plasma, with a vacuum chamber 1·4 metres in dia. and 20 metres long, which they claim is the largest in the world.

NEW IDEAS IN DESIGN

Outstanding products in current manufacture and awaiting development in the U.K.

A Thermocouple for the Surface of High-speed Cylinders

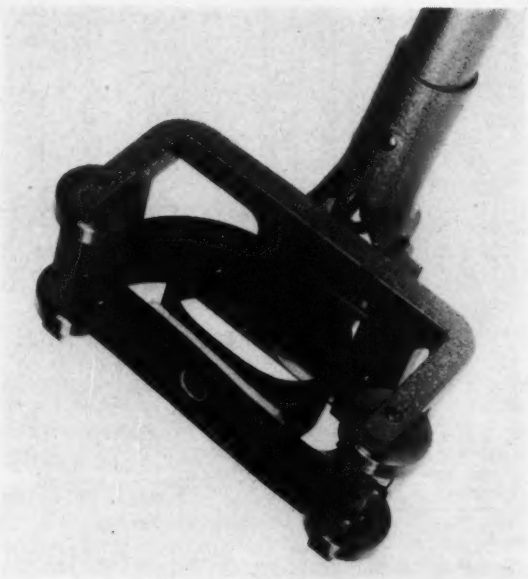
FOR many years, standard strip thermocouples have been used for measuring the surface temperatures of high-speed cylinders such as those in paper-making processes. For peripheral speeds of up to 200 ft./min. these thermocouples are reasonably satisfactory, but at greater speeds significant errors are caused by frictional heat.

The new surface pyrometer, developed by the Cambridge Instrument Company in conjunction with Bowater Research & Development Co. Ltd., is designed for more universal purposes, as it can be used successfully to measure surface temperatures of cylinders with peripheral speeds of 2,000 ft./min. or more.

Fundamentally the pyrometer consists of two parts, a wheeled cradle attached to a tubular handle by a universal joint, and a heat-sensitive element sprung beneath it.

The element is built up on a flexible phosphor-bronze strip with a central round pocket 0·03 in. deep. At the back of this recess is a thin copper disc thermocouple, with a constantan lead soldered to its centre and a copper lead soldered to a point on its circumference. This disc is held in position by a silastomer moulding, bonded to the phosphor-bronze and reinforced by fibreglass, through part of which the thermocouple leads are led to terminals on the underside of the cradle. Compensating leads to an indicator or recorder are connected to these terminals through the tubular handle. The thermocouple is surrounded by silastomer to reduce heat losses, from the back of the pyrometer, to a minimum.

In practice, the cradle is held against the cylinder so that the phosphor-bronze strip of the heat-sensitive element closely conforms to the curvature of the cylinder and the central pocket is sealed off to prevent heat losses to the atmosphere. The trapped air becomes turbulent as a consequence of the movement of the cylinder past it and quickly and accurately reaches a temperature equilibrium with it.



This temperature is measured directly by the copper disc thermocouple and indicated or recorded by a millivoltmeter instrument.

Tests so far carried out indicate that the pyrometer has a response time (to reach 99 per cent of its final value) of about 1¼ min. and that total errors of 100 deg. C. (compared to total immersion readings) do not exceed ± 2 deg. C.

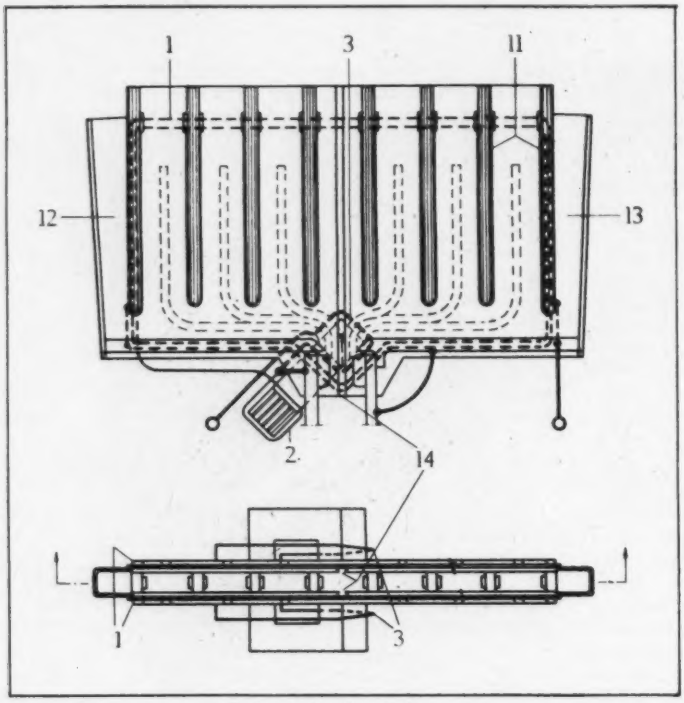
New Type of Circuit Breaker for Converter Substations

ASEA. of Sweden have introduced a new circuit breaker for protection against short circuits on high-power d.c. circuits. The circuit breaker, which has been developed in order to meet the latest requirements as to high breaking capacity, while at the same time retaining compactness, is illustrated over the page. It is rated at 3,000 V., 1,600 amps., the main new feature being the arc-extinction device. Apart from requiring considerably less space than earlier designs, it is claimed to exert a better control over the arc and consequently over the highest arc voltages occurring. Three types of tripping are possible:

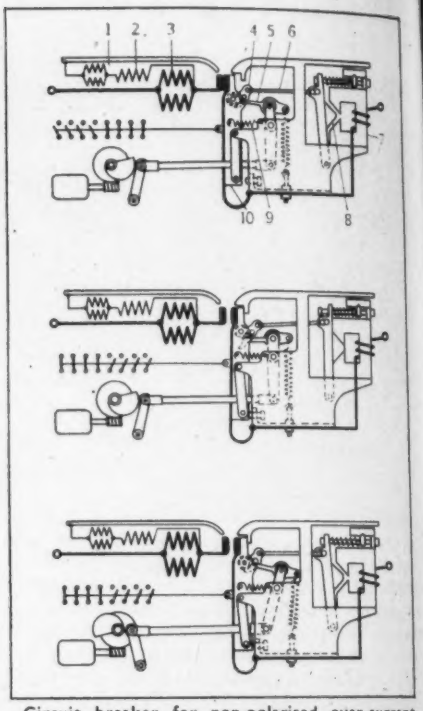
Firstly, reverse-current tripping, which is used mainly when the circuit breaker is employed as a cathode switch for mercury-arc rectifiers. In the case of a 1,600-amp. circuit-breaker, tripping takes place for a reverse current of approximately 150 amps.

Secondly, polarised over-current tripping, which implies that the circuit breaker trips for an over-current in only one direction of the current. This form of tripping is used in substations for traction systems. In these stations two or more lines are connected together. When one of the lines is subjected to a high load, it will be supplied from the other ones. If a short-circuit occurs on one of the lines, this line is tripped by its high-speed circuit-breaker, the other circuit breakers being unaffected.

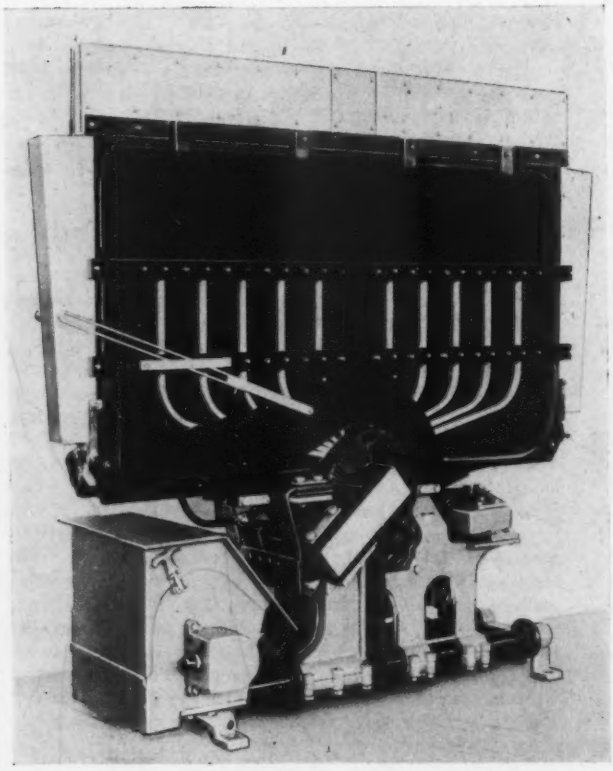
Thirdly, non-polarised over-current tripping in which the circuit-breaker trips for an over-current irrespective of the direction of the current. A circuit-breaker designed for this form of tripping is held closely by means of a patented mechanical latch. No hold-on voltage is consequently needed, and this tripping arrangement is, therefore, preferable when polarised tripping is not required. The circuit breaker-mechanism for a non-polarised circuit-breaker is illustrated here. When the current attains the tripping value, the armature 8 is attracted by the magnet 7, which causes the rod 6 and link 4 to be actuated. The latter then first turn towards the stop in the contact arm 10, thus releasing the latch 5. After this, the force exerted by the armature is transmitted to the contact arm, which is rapidly pulled out. This movement is assisted also by the spring 9, which prior to the tripping held the contact closed with sufficient force. In the circuit breakers designed for reverse-current tripping and

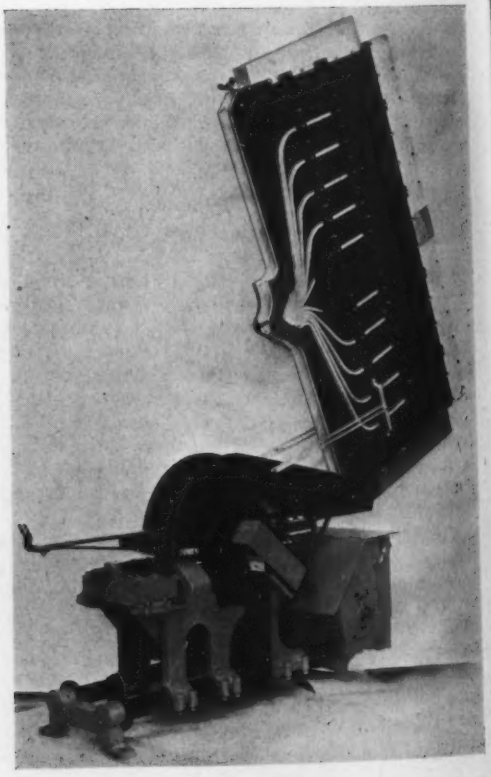


Arc-extinction device.



Circuit breaker for non-polarised over-current tripping.





polarised tripping the mechanical latch is replaced by a hold-on magnet, and the tripping force is imparted by a powerful spring. The arc-extinction device, which is shown schematically, has two permanently energised blow-out coils 3, which generate a strong magnetic blow-out field in the interruption gap between the contacts.

When the contacts open the arc is drawn rapidly up on to the arcing horns, and at the same time the extra blow-out coils, 1 and 2, are connected in circuit. One of these blow-out coils, 2, which is mounted on the same blow-out core as the permanently energised blow-out coils, is intended to assist in the interruption of very low currents.

The other two extra blow-out coils 1, connected in parallel, are mounted, one on each outer side of the arc chute. These blow-out coils generate a magnetic field that strives to draw the arc out and up within the loop they surround.

An arc which is to yield an arc voltage drop of about 6 kV. requires a considerable length, and to provide a better control over the arc, the arc chute has been divided into a number of compartments with partitions between the compartments clad with resistor strips 11 of a highly resistant alloy steel possessing an elevated melting point. When the arc is drawn up into the chute, these resistor strips are connected in circuit at the same time as the arc is split up into a number of smaller arcs, connected in series via the resistor strips. The short arcs are then drawn up upwards with great rapidity, and thus no damage due to burning will arise on the resistor strips. The total voltage across the break will be very stable and it rises very uniformly and rapidly. The strongly ionised gas formed during the interruption passes not only upwards from the lower part of the arc chute but also out through the ducts 12 and 13. This lessens the risk of ionised gas being forced against the contacts and causing restriking.

The arc chute within which the arc is controlled is made of a material possessing a very high resistance to arcs, and has been provided with insulating slots (14) between the contact poles, thus ensuring a satisfactory insulation.

The circuit-breaker is, in many cases, supplied with a small storage battery to supply the necessary power for operation, only 100 W. being generally necessary. Depending on rate-of-rise of the current, contact opening time is said to be within the range 2-4 milliseconds. (Data abstracted from the *A.S.E.A. Journal*.)

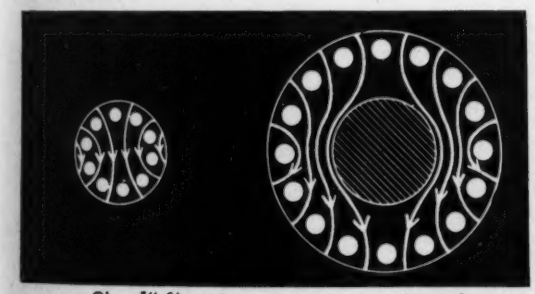
High-frequency Motors for Small Power Tools

THE very high speeds necessary in small hand and machine held tools usually necessitate air motors to achieve the necessary peripheral speed for the cutter, whether this be a dental burr, small drill or mounted point. The range of high frequency motors produced by the Oberg Machine Company AB of Eskilstuna, Sweden, and now available in this country from H. Williams & Son Ltd., of St. Albans, enable speeds of up to 70,000 r.p.m. to be achieved, even higher speeds being attainable on request.

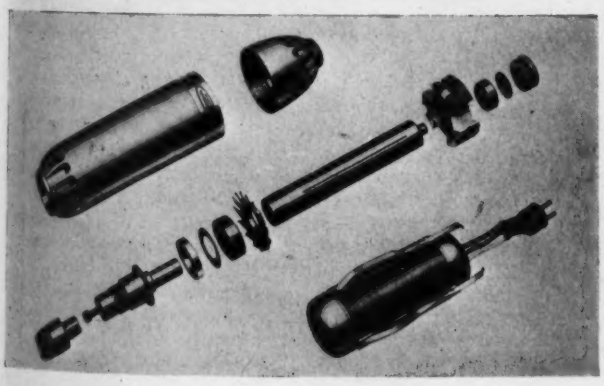
The type of motor used in the Oberg tools is of the 2-pole three-phase squirrel-cage type having a unique rotor. The extreme compactness of the rotor is achieved by eliminating the central hole for the shaft, the laminations being held together by the rotor bars and so forming a solid unit. As there is no central hole to disturb the magnetic field, greatly improved efficiency is claimed.

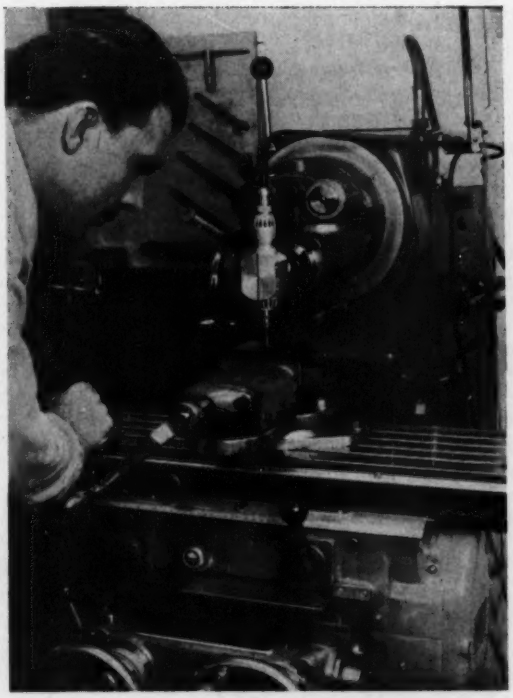
The tools powered with the Oberg motor are supplied by current from one of a range of frequency converters providing around 42 volts at 1,000 c/s. Maximum power outputs from the three converters range from 200 W. to 1,500 W.

The ball bearings used in the Oberg power tool are built to special precision standards and lubrication is provided by built-in reservoirs. It is claimed that attention is only required every 1,000 hr., bearing replacement being easily effected owing to the fact that rotor and stator are self-centring with a patented locking device. The collets available are of two-slit construction and range from 2.35-8 mm. in capacity.



Oberg rotor (left), and conventional rotor with shaft.



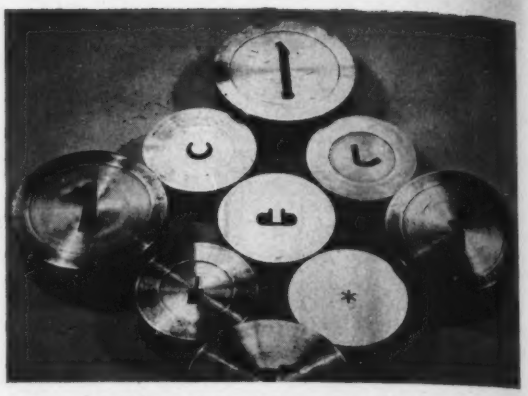


1,700-TON EXTRUSION PRESS

ONE of the most up-to-date and highly mechanised extrusion presses in Britain recently commenced operation at the Froghall works of Thomas Bolton & Sons Ltd. This extrusion press plant, designed and supplied by the Loewy Engineering Co. Ltd., of Bournemouth, consists of a 1,700-ton oil-hydraulic extrusion press with three Loewy Magnethermic mains-frequency induction heaters, and completely mechanised gear for supplying billets to the press and removing the extruded product.

The horizontal extrusion press itself is of a special offset three column design. It has a rotating die-holder so that dies can be brought to an outer station for dressing or changing without holding up production. The press has both die-face and back-cut shears to give the maximum of flexibility in the production of a wide range of products. Hydraulic pressure is provided by ten Towler high-speed oil pumps driven by two 250 h.p. 3,300 volt Laurence Scott motors.

Fully automatic operation of all movements, from the acceptance of the cold billet for heating to the final elimination of the discard and re-closing of the press, is provided in two stages. The first stage consists of discharging a hot billet from the appropriate heater, conveying it to a position in line with the container bore, placing a pressure disc behind it, and then reloading a cold billet into the heater coil. This cycle is completed by pressing a button on the main control desk, when the appropriate signal light shows that the billet is up to temperature.



Group of typical dies used for making copper and brass extrusions. The die profiles are machined by a spark erosion process.

A second button initiates the extrusion cycle proper; this carries through all stages of extrusion cutting off and discard ejection, ending only when the press is ready for the next hot billet. Twelve pre-set extrusion rates are provided to ensure that any size or type of product can be extruded under the most suitable conditions.

IMPROVED ANALYSIS OF HUMAN REACTIONS

FOR the past seven years Douglas Aircraft Company have been engaged in a research programme to develop a simplified form of information presentation for the operators of complex machine systems. These operational work loads are approaching the level at which the human can no longer react and respond effectively. It is evident that ways have to be found to unburden the operator, minimize stress, and delay the onset of fatigue.

In reviewing the past work on fatigue and allied phenomena, one general conclusion of investigators has been that neither fatigue nor impairment of organic functioning can be measured entirely by the work output of the intact organism. Activity may be used as a direct measure of impairment only when such systems as isolated nerve muscle preparation are used in ergo-graphic studies. In these cases very definite indications of change in such parameters as muscle potentials can be demonstrated between a relaxed and active state. When considering the entire organism, however, investigators generally have found it necessary to distinguish among three factors: fatigue, impairment and work output, which are semi-independent variables. The experience of fatigue may arise either through impairment as an immediate after-effect of exercise, or as a conditioned feeling of boredom, distraction or other conflict.

It was known that emotion is characterized by many combinations of bodily change, and it seemed that perhaps some of the more psychological aspects of fatigue might also be indicated from measures of autonomic activity. Fortunately, all body functions can be measured directly as potential changes, or can be converted to electrical form by the use of proper transducers. Some phenomena—such as brain waves, muscle potentials, galvanic skin responses, electrocardiograms, and eye blinks—can be measured directly as electric potentials. Other phenomena such as skin temperature can be transduced to electrical form by means of thermocouples. In similar fashion, respiration and blood pressure can be transduced by microphones and strain gauges.

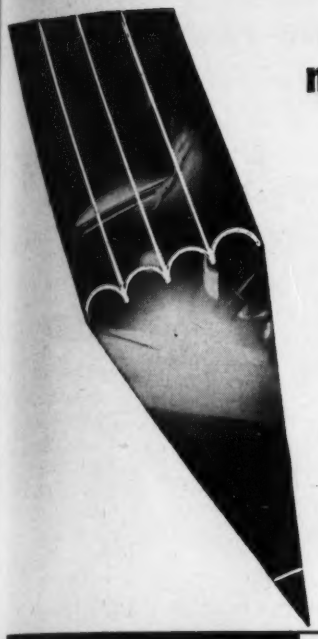
It became apparent that conventional sensors left much to be desired. In particular, the wiring harness was unwieldly and distracting to the subject. Accordingly, making use of some of the more advanced techniques of circuitry design and packaging, small integral units consisting of a sensor, amplifier and f.m. transmitter were designed. These so-called "mini-sensors" could be readily attached to the subject to detect bio-electronic changes and transmit them to a remote receiver 50 ft. or more away. The sensor transmitter unit was only a little bigger than a sixpence.

Concurrently with the development of sensing devices, effort is also being expended toward applying the data-processing techniques utilized in engineering studies to the faster analysis of physiologic data. Anyone who has had to reduce basic data from physiologic records will appreciate what a tedious and time-consuming task this is. In laboratory simulation and in flight test work, the effective utilization of results is considerably reduced unless they are made available in a very short time.

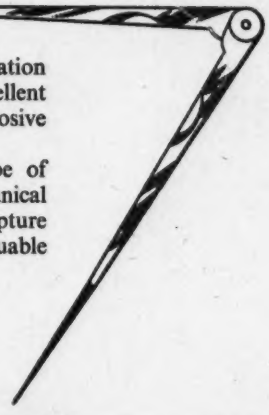
While conventional techniques usually involve direct write-out devices such as the direct-writing electrocardiograph, improvements can be made by computing and displaying integrated signals, r.m.s. errors, or even digital readouts. In the case of monitoring the performance of individuals being subjected to stress, such as test pilots or astronauts in space capsules, a fast-response time analysis and data presentation system is needed.

Physiology teaches that each of the parts of the human body function, not in isolation, but as a highly inter-related and inter-dependent organizational structure. In monitoring man's performance, two classes of information are required: descriptive information, and predictive information.

Abstracted from a paper presented by H. L. Wolbers (Douglas Aircraft Co. Inc.) to the American Rocket Society.



material answer



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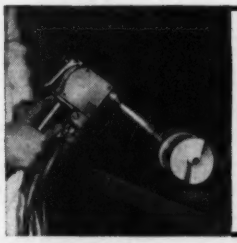

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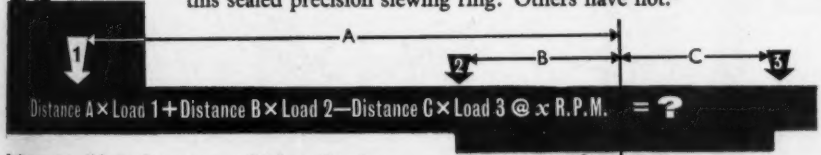
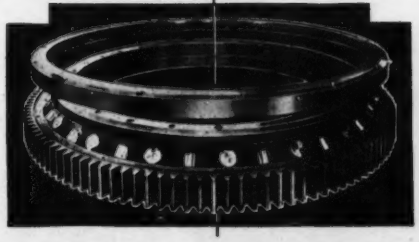


It is not possible in the space available to list the applications against their appropriate industries as many of them are duplicated. Here are some of the many diverse applications we have encountered:

Arc Furnaces
Ball Mills
Breakdown Cranes
Centre Line Davits
Chemical Tank Agitators
Diesel Electric Mobile Cranes
Dock Side Capstans
Dock Side Grabbing Cranes
Dock Side Cranes
Dustbin Turntables
Electric Overhead Travelling Cranes
Electric Pillar Cranes
Fixed Deck Cranes
Furnace Ladle Bogies
Hose Handling Turntables
Howitzer Slewing Rings
Ion Chamber Handling Machines
Hydraulic Mobile Cranes
Hydraulic Platforms
Lift Turntables
Mine Hoisting Gear
Missile Launching Platforms
Mould Box Press Turntables
Rocker Shovels
Oil Tanker Cleaning Booms
Oil Derricking Cranes
Pan Pelletizers
Radar Scanners
Radio Telescopes
Range Finders
Railway Track Layers
Railway Loco Cranes
Rail Mounted Deck Cranes
Rolling Mill Control Pulpits
Rotating Silos
Rotating Work Platforms
Rotating Quenching Tanks
Sewage Agitators
Ship-to-Shore Gangways
Ship's Engine Room Cranes

THE BEST ANSWER IS A



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RIGID OPERATIONAL STABILITY (The principle of twin paths and pre-loaded crossed rollers effectively interlocks crane superstructure and base eliminating "rock")

NO ADJUSTMENT (No King Post Bushes, Nuts, etc.)

LONG TROUBLE-FREE LIFE (Apart from lubrication no maintenance required)

BETTER DISTRIBUTION OF SHOCK LOADS (Multiple, pre-loaded taper rollers with long line contact spread all operational loads)

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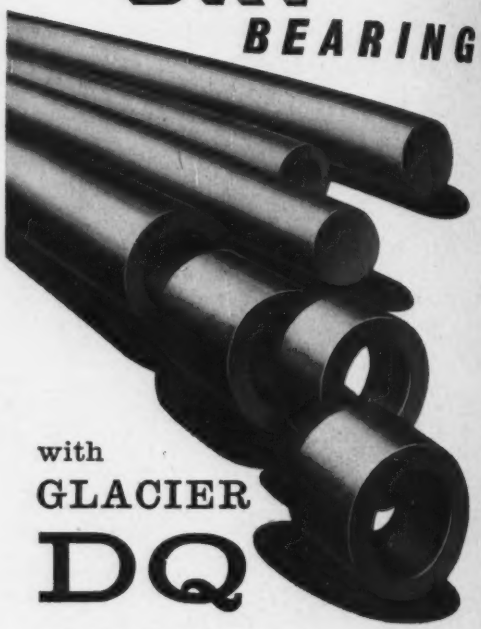

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OVERSEAS NEWSLETTER

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Pivot-roof Goods Truck

Modern rationalised methods of material handling are being introduced to the railways both at home and overseas, and loading of heavy and bulky freight such as cases, bales, steel strip and wire rolls, billets, sheets and machinery by crane greatly facilitates this operation which requires the use of open wagons. For protection, the wagons are usually covered by tarpaulins which are not always watertight. To overcome these difficulties the Schindler Carriage and Wagon Co. Ltd. of Switzerland have developed and built a goods truck fitted with a pivoted roof, which, in the open position, allows free access to the whole floor area of the wagon from the top; in the closed position the roof is watertight. Goods which are shipped in bulk, such as grain, may be transported in this wagon without danger of spoiling.

The roof consists of two half shells supported on pivots fitted to both end walls of the wagon so that they may be swung outward. Both half roof shells are coupled together by an appropriate and simple system of links, their weight being counterbalanced by springs in such a way that operation by one or two men is easily effected. A special advantage for use on electrified lines is the fact that it is unnecessary to step on top of the wagon roof for operating the latter. In the closed position, the roof is secured by a locking device against unintentional opening.

The prototype wagons as supplied to the Swiss Federal Railways are approximately 35 ft. in length with a height of roof top just over 11 ft. above the rails. The max. load is 28 ton, tare weight 12.3 ton. The pivoted roof and side wall panels of the prototype wagons are built of light alloy sheets but may be made of steel. Also, the dimensions as quoted above may be altered if required. The roof is designed in such a way as to prevent condensate water dripping on the goods.

Slippery Rubber

Quantum Incorporated of Connecticut have developed a process involving a series of steps whereby organic coatings of varying thickness are grafted to the surface of finished rubber parts. Through subsequent processing steps, the coatings are converted to a chemical form which possess a low coefficient of friction. Since the coatings are extensible, they will not rupture or otherwise suffer when the rubber is elongated within reasonable limits, as in the installation and application of O-rings, lip seals, and similar parts.

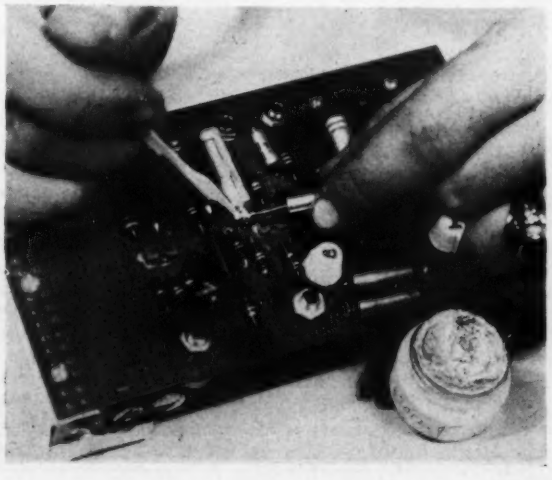
An inherent advantage of the process lies in the fact that the low friction surface can be applied to a variety of rubbers without impairment of physical and chemical properties of the basic rubber, thus permitting relatively free selection of rubber types to meet application requirements. Low friction coatings have been applied successfully to natural, butyl, butadiene-styrene, butadiene-acrilonitrile, and polychloroprene rubbers. The coefficient of friction of the processed materials is approximately 0·2 as compared with values of 2·0 and above for normal rubber surfaces. Although the Company does not have an agent in the U.K., they wish to explore the possibilities of a licensing arrangement.

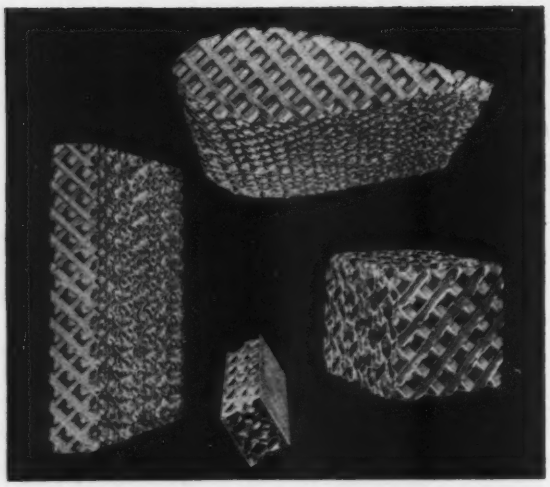
Epoxy Solder

A silver conductive epoxy with a resistivity between 0·01 and 0·0001 ohm-cm has been developed by Epoxy Products Inc. and can be used at room temperature to make a strong, low resistance bond. This epoxy solder is available in two paste forms—a one component heat curing (as low as 125 deg.C) paste, and a two component room temperature cure paste. It is ideal for field repair work, particularly on crowded printed circuits where solder temperatures might damage heat sensitive components. Its bond strength is superior to usual metal solders and it can be used to make a conductive bond with practically any material. The shear strength of a steel-to-steel bond is 3200 p.s.i., while aluminium has approximately the same shear strength, although this is difficult to measure because the aluminium begins to tear before the bond fails.

When the bond hardens it can be plated by conventional plating techniques, after which ordinary soldering can be carried out on the plated surface. Unlike conventional soldering and brazing, epoxy solder requires no flux and typical applications include bonding electronic tube caps to the glass tube, bonding the tantalum slug to the can of a tantalum capacitor, connections made to heat sensitive diodes and transistors, and grounding aluminium capacitors to steel chassis.

Conductive epoxies are intended primarily for replacing soldering and brazing operations which require high temperatures. When used with dissimilar metals, epoxy solder offers a bonding technique where no type of soldering or brazing would be possible.





Cross-laminated Core

Trussgrid, a product of General Grid Corp., Army Chemical Centre, Maryland, U.S.A. is a stable, naturally vented, rigid core material made of cross laminated corrugations. This new core material combines the advantages of the ordinary honeycomb type core with the volume stability of a foam type core. Since it has considerable strength in all three planes, it can be cut to size and shape easily, thus eliminating cell reinforcement with ice, resins or waxes during machining. On an equal density basis, Trussgrid has twenty-five times the crushing strength of regular honeycomb perpendicular to the cell axis.

The natural venting of the core offers a new potential in a cooling or heating sandwich structure, and a sandwich panel made with this core could be used as a vacuum table by having holes in one face and by exhausting the air in the panel, using the core as a large duct. Since there is no direct straight line flow through the core, it could also be used as a flow diffuser or mixer for gases or liquids and at the same time offer some filtration effect. The isotropic characteristics and the absence of any weak planes make the core suitable for energy absorption applications where load application cannot be always parallel to the cell axis of conventional honeycomb.

The new core material is currently available in aluminium although it can be made from any sheet material. Preliminary strength data indicates a flexual shear strength of 200 p.s.i. longitudinal and 80 p.s.i. transversely for a core of density of 4 lb./cu.ft. Densities can be varied between approximately 2 and 8 lb./cu.ft.

Paper Threads, Filaments and Fabrics

With methods hitherto employed, it has not been possible to spin fine threads from paper, and this has meant that the coarse threads have been confined to the manufacture of coarse packaging fabrics, backing for carpets, and for string and cordage. In addition, the older methods gave rise to a very large percentage of waste, several operations being needed in a single cycle to convert the roll of paper into thread.

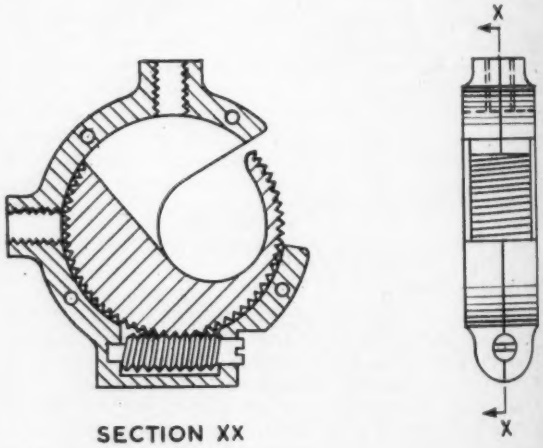
Mr. Ronald Marks of Dallas (Texas) has developed a new patented method by which fine threads or filaments can be produced in a single operation from the roll to the bobbin. This is being handled by Segard & Co. of Tourcoing, France. In the new technique, materials such as polyethylene, cellophane, polyamide and non-woven webs and foils can also be converted into threads. With a single machine the roll of paper or foil is cut, twisted and wound on a bobbin, and during these operations the thread also passes through a bath to make it flexible, thus assisting the twisting operation. The invention was tested by manufacturing scrim cloth for various food products. This was the starting point for a much wider variety of uses involving larger quantities. The large selection of meshes, designs and shapes obtainable with modern knitting machines enables a tremendous number of finished products to be obtained.

Made from this thread, the coarser fabrics can be used for packaging, sacks of all kinds, backing for carpets, etc. in competition with jute. It can be used for reinforcing glass fabrics and may be used in furniture manufacture to give rigidity and act as a base for resin coatings. The fabric can be used to cover concrete while drying, and to reinforce bitumen roof coatings.

In the United States work has been carried out on clothing uses, such as linings, tailored wear, hats and special clothing. Paper sheets can be used for hospital bedding which is thrown away after use although a typical paper fabric can be washed thirty times in a domestic washing machine without deterioration. One of the major uses of paper fabrics in the future may be in laminated plastics articles, since polyvinyl chloride reinforced with paper is a strong, cheap material for the manufacture of car trim, seat covers and impermeable packaging of high strength. Recently, the American army has used epoxy-paper laminates for insulating high temperature linings for turbines, rockets and missiles.

Clamping Device

A recent French patent describes three ways of simply clamping cylindrical objects such as pipes and bars, and one of these is shown in the accompanying drawing. In this form, the casing is made from two complementary moulded shells, the locking element having a toothed external surface with a mating worm screw built into the lower part of the casing; the resulting linkage is non-reversible. In these conditions, the locking element can be



SECTION XX

operated by turning the worm by means of a screwdriver, the non-reversible nature of the linkage avoiding any premature release or unlocking.

The device, according to the inventor, can be easily made on an industrial scale at a low price, and offers great safety in use because a tube or conductor held in the body cannot fall out of its own accord. Moreover, clamping can be effected without requiring the use of tools. The invention is not limited only to the type of construction described—it can be varied structurally in many ways.

FROM IDEAS TO IRONMONGERY

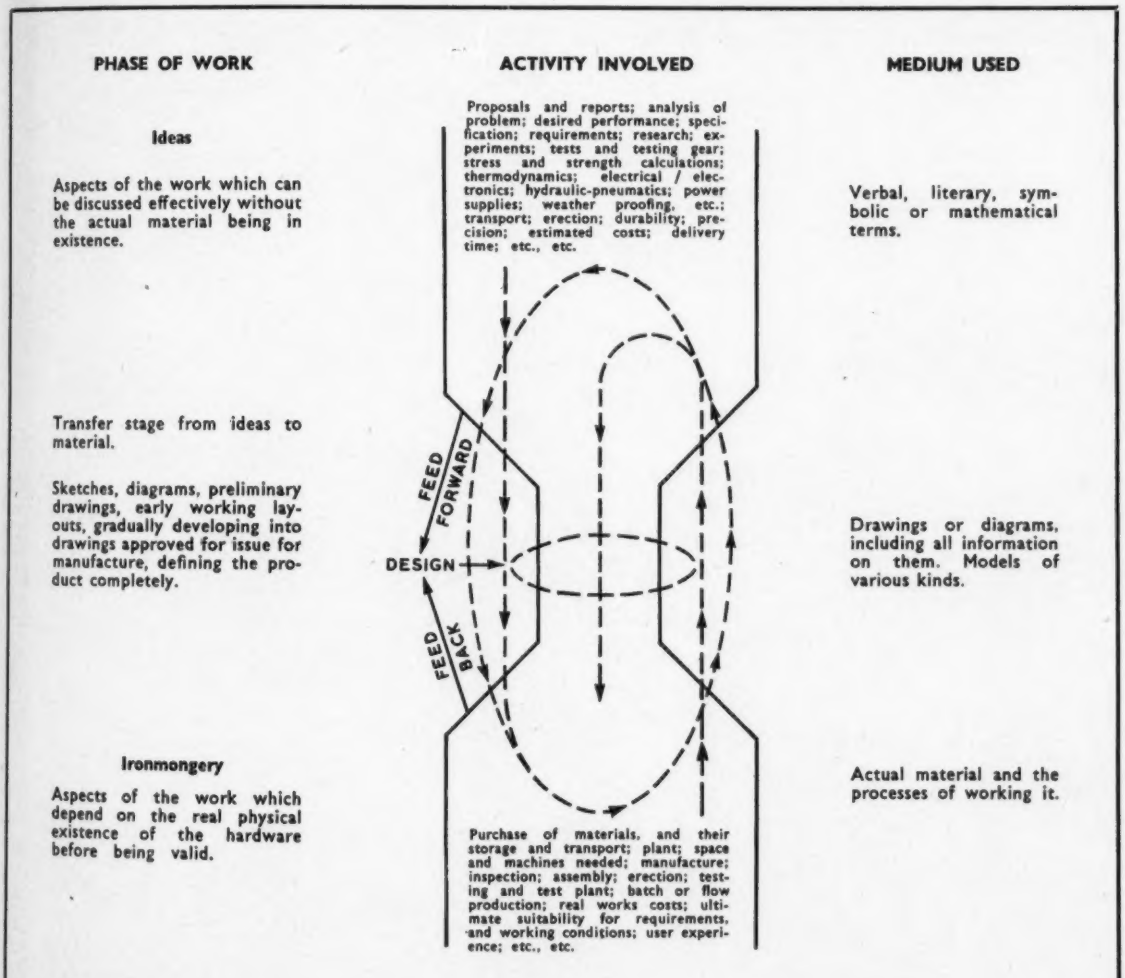
by HUGH CLAUSEN, O.B.E., I.S.O., B.Sc.(Eng.)

MUCH is said about "research", "the application of science to industry", and "productivity", but less attention is paid to the links between them, the intermediate stages, where the transfer from ideas to ironmongery actually takes place—the design stage in particular.

It is in this stage that an idea in verbal, literary, or symbolic terms, or diagrams, acquires for the first time a clear definition in material terms, and with this there comes into being the possibility of its existence as a real material thing. Here, also, is the place where defects which will become apparent in the use of the material can be effectively corrected.

We can split up the factors concerned with almost any engineering project into groups or phases of work, as shown on the above diagram. The upper part contains those aspects which can be considered in the abstract, in more or less general terms; they do not depend on the existence of the material hardware to give them reality or validity. They are—usually—the foundations on which the design of the hardware is based. The lower part contains those aspects which need the existence—real or potential—of the actual material thing, complete in all its details, to give them validity.

To exist, the hardware must have been designed (and


PHASE OF WORK
ACTIVITY INVOLVED
MEDIUM USED
Ideas
Aspects of the work which can be discussed effectively without the actual material being in existence.
Proposals and reports; analysis of problem; desired performance; specification; requirements; research; experiments; tests and testing gear; stress and strength calculations; thermodynamics; electrical / electronics; hydraulic-pneumatics; power supplies; weather proofing, etc.; transport; erection; durability; precision; estimated costs; delivery time; etc., etc.
Verbal, literary, symbolic or mathematical terms.
Transfer stage from ideas to material.
Sketches, diagrams, preliminary drawings, early working layouts, gradually developing into drawings approved for issue for manufacture, defining the product completely.
FEED FORWARD
DESIGN
FEED BACK
Drawings or diagrams, including all information on them. Models of various kinds.
Ironmongery
Aspects of the work which depend on the real physical existence of the hardware before being valid.
Purchase of materials, and their storage and transport; plant; space and machines needed; manufacture; inspection; assembly; erection; testing and test plant; batch or flow production; real works costs; ultimate suitability for requirements, and working conditions; user experience; etc., etc.
Actual material and the processes of working it.

Ideas can move upward anywhere. The only path by which they can *usefully* come down is through the design bottleneck—the drawing office or equivalent place where designs are worked out as a complete statement, and where manufacture and process instructions are formulated and issued with authority.

thereby defined) somewhere. The middle section—design—is the channel in which the ideas and notions of the upper section are born and acquire definition and reality—the possibility of existence in real material form. It is mainly here that the real character and performance of the product are determined. Its final products are detail drawings and process instruction to be issued for manufacture and specifications for trials and tests.

The main point to notice is that any results of work or thought in the upper part can only come down *usefully* into the lower part by passing through the neck. If, as sometimes happens, they pass down outside this, the result is a further upward flow outside. This leads to a circulation between top and bottom, often carrying a large wattless component, and more congestion on the effective way down.

Ideas can always move upwards, as for example, manufacturing considerations, or questions arising from results of trials or experiments, but any response can only effectively come down through the neck.

There is a very real danger in strengthening the research or analytical staffs dealing with the upper part, or those dealing with the production side in the lower part, unless the design staff, which has to handle and process *all* the work, is kept up to adequate strength.

Production departments should not make alterations, even small ones, without consulting the design department, which becomes—or should become—the ultimate design authority, approving drawings for manufacture, and also carrying responsibility for performance.

One of the most important factors in *any* type of engineering is the feed-back link from ironmongery to design—this is the means of keeping "design" on the rails, and of providing an effective storage for the lessons of practical experience. Any sign of weakness in this feed-back link should be attended to at once. It is a most serious symptom.

It has been well said elsewhere that though the engineer need not be a designer, the designer must be an engineer, with wide knowledge of machines, methods, money, materials, men and management, and an ability to get the best out of them.

ENGINEERING MATERIALS AND DESIGN CONFERENCE

THE following papers are to be given at the Second Engineering Materials and Design Conference, at Earls Court, London, from November 13 to 17, 1961:—

Monday, November 13		
a.m.	(1) Opening address.	
	(2) Design problems with Bluebird.	L. H. and K. W. Norris (Norris Bros.).
p.m.	(3) Organisation of a materials department.	F. C. Carpenter (Smiths Aircraft Instruments Ltd.).
	(4) Metallurgy applied to the selection of metals.	D. Birchon (R.N.S.S.).
Tuesday, November 14		
a.m.	(5) Elastomers in engineering.	D. A. Smith and D. G. Franks (National College of Rubber Technology).
	(6) Recent developments in insulating materials.	J. Wainwright (English Electric Co., at Stafford).
p.m.	(7) Recent developments in graphite.	Prof. Kennedy (College of Aeronautics).
	(8) Adhesives for engineering.	E. J. Catchpole (C.I.B.A. [A.R.L.] Ltd.).
Wednesday, November 15		
a.m.	(9) Designing for diecastings.	F. Clymer (F. H. Lloyd & Co. Ltd.)
	(10) The case for steel castings.	H. K. Barton (H. K. Barton Associates).
p.m.	(11) Some properties, applications and potentialities of investment castings.	L. S. Taylor (G. L. Willan Ltd.) and A. G. Mason (Deritend Precision Castings Ltd.).
	(12) Steels for the design of low-temperature equipment.	E. Gill (International Nickel Co. [Mond] Ltd.).
Thursday, November 16		
a.m.	(13) Recent developments in permanent magnet materials.	J. E. Gould (Permanent Magnet Association).
	(14) Sintered porous media.	G. Brewer and A. Clayton.
	Sintered friction materials.	R. I. Blackwell and J. C. Hewitt (all of Sintered Products Ltd.).
p.m.	(15) Plastics coatings.	N. Vinson (Plastic Coatings Ltd.).
	Plastics-coated steel.	Francis Smith (John Summers & Sons Ltd.).
	(16) Composite structures and applications.	B. Noton (The Aeronautical Research Institute of Sweden).
Friday, November 17		
a.m.	(17) Use of aesthetics in machine design.	F. C. Ashford (industrial design consultant).
	(18) Relationship of engineering and industrial design, and the role of C.O.I.D.	W. H. Mayall (C.O.I.D.).
p.m.	(19) Influence of corrosion on the design of chemical plant.	E. Warde (Henry Wiggin & Co.).
	(20) Loading statistics as a basis of structural and mechanical design.	T. Haas (B.W.R.A.).

LETTERS TO THE EDITOR

Encouragement with Interest

Sir,

I read the May 1961 issue with more than my usual interest. Your remarks in "The Human Element" are to be applauded, bringing a breath of fresh air to ventilate the fug of boredom which is so characteristic of many so-called organisations.

It has been my experience that engineering firms regard their junior graduate employees as so many human calculating machines (or drafting engines!) which they are obliged to utilise at the lowest possible cost to themselves until such time as a computer may be able to take over.

The deadly atmosphere of many drawing and "design" offices has to be experienced to be credited, and the resulting frustration index is high enough to interest a psychologist. It is a tribute to the enthusiasm of young engineers that they do sustain the load for so long.

Recognition for work done is conspicuous by its absence, and it is commonplace to find individuals in charge of design departments at odds—or open warfare—with their subordinates.

Notwithstanding this peculiar state of affairs, engineering design remains the finest and most satisfying of professions, provided it may be pursued in an atmosphere of comradeship under a man possessing some of the attributes of a leader.

Britain's rise to engineering eminence was largely due to the outstanding qualities of a *few* born leaders. Her present state of mediocrity can be ascribed to the lack of leaders of any sort who are sufficiently unencumbered by "stuffed shirts" and similar "administrators". Possibly her future return to world leadership could be brought about by endeavouring to educate whole men in the science of leading other men. We do not need a higher output of engineers and scientists, we require men who can utilise their talents to the fullest advantage. These are not all born—they can be made.

C. A. Satterthwaite
c/o School of Engineering,
University of Canterbury,
Christchurch, New Zealand.

The Soviet Exhibition

Sir,

As an engineer, I found the Soviet Exhibition at Earls Court exasperatingly inadequate for a detailed study of technical achievement. Instead of the customary stands grouped according to products, a series of twenty-two spacious halls beguiled the visitor with various aspects of Soviet industry, science and way of life. It is obvious that the U.S.S.R. has a good deal to learn about the presentation of industrial and technical exhibitions, and one must sympathise with the difficulties which faced the U.K. organisers.

Only two of the exhibition's halls were devoted to materials as such—these were the halls of chemistry and of metallurgy. However, much of the space in these halls was taken up by large-scale models of chemical plants and steel mills, leaving only a few stands and a number of wall charts to give information about the products themselves.

As far as can be judged, the Soviet plastics industry is now able to produce most of the materials now manufactured in Western countries, and it was stated that the current seven-year economic plan envisages an eight-fold increase in plant capacity. This will be mainly for the manufacture of polyester resins for glass laminates; epoxy resins; silico-organic compounds; polystyrene and its co-polymer; polyamide resins; foam-urethanes; and polythene and polypropylene.

The hall of metallurgy was even more disappointing from an engineer's point of view, since it consisted mostly of more murals and model factories, some sample extrusions and ingots, and a number of films in which the commentaries extolled, in American accents, the happy life of the operative in a modern Soviet steel works.

A detailed examination of the exhibits left a general impression that the quality of many of the products leaves something to be desired when judged by current Western standards. On the whole finish was poor, and the styling, where there was any conscious attempt to introduce it, was not attractive. The exceptions were in optical equipment, and in some cases electronic apparatus, where the finish was quite good. Nowhere, however, was there any indication of an ergonomic approach to equipment design, or an attempt to evolve new designs or shapes for existing devices.

In the field of research there were a number of exhibits in the hall of science which showed that various institutes of the U.S.S.R. Academy of Sciences are developing new techniques for the handling and treatment of materials, and are also investigating the structure of materials under extreme conditions. Amongst these exhibits were several instruments for spark machining, a plasma arc jet developing temperatures of 15,000 deg. K. and capable of cutting carbides, and an ultrasonic concentrator producing a localised pressure of 400 atmospheres.

Detailed information about any of the exhibits was difficult to obtain, and the literature available was generally inadequate to assess the merits of equipment in comparison with Western equivalents. Some pamphlets did attempt to set out the main characteristics of the units described, but only too often the information was ambiguous or tantalisingly brief. Other pamphlets consisted of technical or historical introductions to a particular subject, and stopped short of specific details or applications.

E. Lloyd Thomas
Lantern Lodge, Chiltern Hill,
Chalfont St. Peter, Bucks.

National Committee for Research into Teaching and Examining Engineering Design

Sir,

While the original proposals for a diploma in engineering design were much criticised, there was at the same time great interest in the possibility of some kind of course being made available to the student of engineering design. There has been a steady movement over the past year from the vague realisation that something is lacking in the designer's training, towards specific proposals for the introduction of courses in project design at technical colleges.

Over the past year a group within the Institution of Engineering Designers has initiated correspondence on the subject, and ideas have been exchanged. After a provisional programme had been prepared it became evident that this group, in order to make further outside contacts and enquiries, should act as a committee with suitable terms of reference. Thus the National Committee for Research into Teaching and Examining Engineering Design was formed.

The Principal Members of the Committee have each contributed (by means of published work, college courses, programme formulation, reports, and so on) to the general philosophy of teaching and examining engineering design. In this connection, the recent experimental course in project design carried out at Huddersfield College of Technology and reported in *The Engineering Designer* (May 1961) was of particular interest. This course, which was run by one of our Principal Members, was regarded as a success at Huddersfield, and it has been decided to continue it next year.

A questionnaire was recently circulated to members of the Institution of Engineering Designers in an effort to establish the actual connection between present college courses and engineering design. In the replies, some interesting trends have been noted, but it is too early to state results at this stage.

Acting as an independent body, the Committee hopes to carry out a full investigation covering the needs of industry; the potential of colleges to teach engineering design; methods of teaching and examining the subject; suitable contents for textbooks covering project design work; course contents; methods of assessing to maintain a national standard; and other relevant matters.

In due course the Committee hopes to publish the results of this enquiry. Wherever possible, existing Higher National courses will be compared with experimental Project Design courses, and details of alternative courses advanced.

In a voluntary enquiry of this kind we welcome help from any persons or organisations interested, who should contact me.

W. A. A. Witham
8 Castlehill Drive,
Newton Mearns,
Renfrewshire,
Scotland.

What saves a cylinder from losing its head?

How does a cog-wheel know when to turn, what makes a casting lasting? What stops a gear from gritting its teeth, what saves a sump from fasting?

In short: what is behind the workings of nearly *every* moving part in nearly *any* machine you care to think of? The answer is filtration—modern, tried-and-trusted filtration of the kind in which Auto-Klean specialise. The Auto-Klean literature will show you the extent of their range. That is why when you specify Auto-Klean you can be sure of the best in modern filtration techniques.

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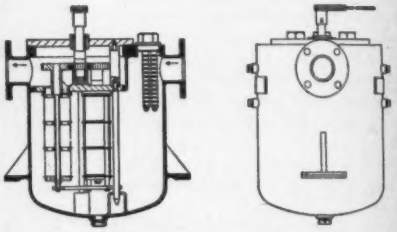
The 30M4 is specially recommended for all grades of oils. It can also be used, however, for distillates, water chemicals, beverages, paints, resins, pulp and industrial liquids of every kind.
Principle: Edge-filtration using four all metal plate-type filters. Three magnetic filters on the inlet side give added protection against micronic ferrous particles.

. . . This AUTO-KLEAN 30M4 self-cleaning filter



Advantages: (1) Full flow filtration. *All* the liquid passes through the filters to the *clean* side of the system. (2) Low pressure loss, ensuring high efficiency. (3) Self cleaning without dismantling or interrupting the flow. Two turns of the handle are all that is necessary. (4) Long life—lasts the life of the engine or plant. (5) Saves space and weight—large capacities relative to size.
Data: Handles up to 11,000 gallons per hour of lubricating oil in a defined mesh of 0.003". Defined meshes range from 0.0015" to 0.008". Maximum working pressure 50 p.s.i. Steam jacketed designs for high temperatures are available.
Full details sent on request

A range of filters is also available for varying applications and flows up to 150,000 gallons per hour.

SPECIAL-PURPOSE BRAZING ALLOYS

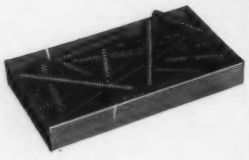
Engineering Materials and Design
DATA SHEET No. 66

A range of special-purpose brazing alloys has been developed, opening a much wider field of brazing techniques. Many operations which hitherto entailed welding or mechanical assembly now lend themselves to brazing, with resulting economies in time and equipment. For maximum strength in brazed assemblies, lap joints are normally recommended, and correctly designed joints will possess strength in excess of that of the parent metal. The choice of a brazing alloy of appropriate melt range can lead to assemblies of greater strength than can be obtained by welding, as the deleterious effects on the structure of the parent metal, arising from overheating during the welding cycle, may be avoided.

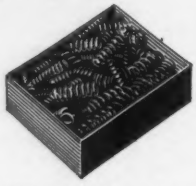
Alloy	Tensile Strength p.s.i. (t.s.i.)	Elongation on 10 in. (%)	Hardness (DPN)	Typical Brazing Temperature (deg. C.)	Application
Silver-Copper (72 Ag., 28 Cu.)	58,300 (26)	30	88	800	Good vacuum properties. Not suitable for bridging large clearances.
Gold-Copper (80 Au., 20 Cu.)	67,200 (30)	17	250	910	Outstandingly good vacuum properties. High resistance to corrosion.
(60 Au., 40 Cu.)	60,500 (27)	38	112	930	Has plastic range, therefore more tolerant of joint clearances than 80/20 alloy above.
Gold-Nickel (82 Au., 18 Ni.)	101,000 (45)	5	245	970	Ideal for ultra high vacuum. High resistance to corrosion.
Silver-Copper-Palladium (68·4 Ag., 26·6 Cu., 5·0 Pd.)	65,000 (29)	23	90	815	Excellent flowing and wetting properties. Preferred joint clearance about 0·002 in., but joint gaps of up to 0·020 in. may be bridged where strength is of less importance. Selection from range of alloys enables step assembly brazing to be carried out. Suitable for vacuum applications. Alloys containing more than 10% palladium do not give rise to stress corrosion cracking in nickel-iron low expansion alloys.
(58·5 Ag., 31·5 Cu., 10 Pd.)	69,500 (31)	22	75	860	
(52 Ag., 28 Cu., 20 Pd.)	71,600 (32)	25	140	905	
(65 Ag., 20 Cu., 15 Pd.)	67,200 (30)	20	120	905	
(54 Ag., 21 Cu., 25 Pd.)	74,100 (33)	15	185	955	
Silver-Palladium (95 Ag., 5 Pd.)	31,300 (14)	28	50	1,015	
Copper-Palladium (82 Cu., 18 Pd.)	49,300 (22)	30	85	1,095	
Copper-Palladium-Nickel-Manganese (55 Cu., 20 Pd., 15 Ni., 10 Mn.)	89,500 (40)	35	135	1,110	Developed for nuclear energy application. High resistance to molten alkali metals. Suitable for joining thin sections of stainless steel and nickel-base alloys.
Silver-Palladium-Manganese (75 Ag., 20 Pd., 5 Mn.)	40,300 (18)	11	95	1,120	Excellent creep resistance at elevated temperatures. The 64% Ag. alloy is not recommended for use with Nimonic alloys.
(64 Ag., 33 Pd., 3 Mn.)	71,600 (32)	25	130	1,220	
Nickel-Manganese-Palladium (48 Ni., 31 Mn., 21 Pd.)	118,720 (53)	7	330	1,125	Suitable for elevated temperatures and for creep resistant metals. Low neutron capture cross section. High resistance to molten alkali metals.
Palladium-Nickel (60 Pd., 40 Ni.)	112,000 (50)	30	224	1,250	High strength at elevated temperatures. Good vacuum properties. Suitable for joining thin sections of stainless steel and nickel-base alloys.

Data by courtesy of Engelhard Industries Ltd.

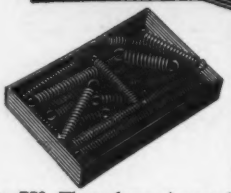
EXPERIMENTAL SPRINGS?



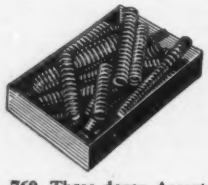
No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **15/-.**



No. 98A. Three dozen Assorted 1″ to 4″ long, $\frac{1}{4}$″ to $\frac{3}{4}$″ diam., 19G to 15G. **6/6.**

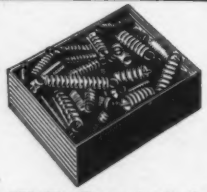


No. 753. Three dozen Assorted Light Expansion $\frac{1}{4}$″ to $\frac{1}{2}$″ diam., 2″ to 6″ long, 22 to 18 S.W.G. **12/-.**



No. 760. Three dozen Assorted Light Compression Springs. 1″ to 4″ long, 22 to 18 S.W.G., $\frac{1}{4}$″ to $\frac{1}{2}$″ diam. **7/6.**

No. 757. Extra Light Compression, 1 gross Assorted, $\frac{1}{2}$″ to $\frac{7}{16}$″ diam., $\frac{1}{4}$″ to 2$\frac{1}{2}$″ long, 27 to 19 S.W.G. **18/-.**



No. 758. Fine Expansion Springs. 1 gross Assorted $\frac{1}{4}$″ to $\frac{1}{2}$″ diam., $\frac{1}{2}$″ to 2″ long, 27 to 20 S.W.G. **18/-.**

That spring you want . . . in a hurry . . . *where* is it? Pick *what* you want *when* you want it from TERRY'S BOXES OF ASSORTED SPRINGS—our fine range of small boxed assortments of experimental springs. We can show you only a few from the range here. Send a postcard for our full list—and if ever you're stuck with a spring problem send it along to our Research Department —they'll gladly help you out.

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Cut Production Costs with Terry's Wire CIRCLIPS. We can supply immediately from stock—from $\frac{1}{8}$″ to $\frac{5}{8}$″.

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MT31

VISCOSITY CONVERSION

Engineering Materials and Design
DATA SHEET No. 67

For values of Redwood No. 1 below 200-225 seconds, the scales do not give accurate equivalents, the discrepancy increasing with decreasing seconds value. In such cases the following formulas should be used, as applicable:—

For Redwood No. 1, 40 to 85 seconds, centistokes = 0.264 T − 190/T; for Redwood No. 1, 85 to 200 seconds, centistokes = 0.247 T − 65/T, where T is Redwood time in seconds.

Similarly, accurate conversion is not given below S.U.S. (Saybolt Universal Seconds) 200. In such cases the following formulas should be used, as applicable:—

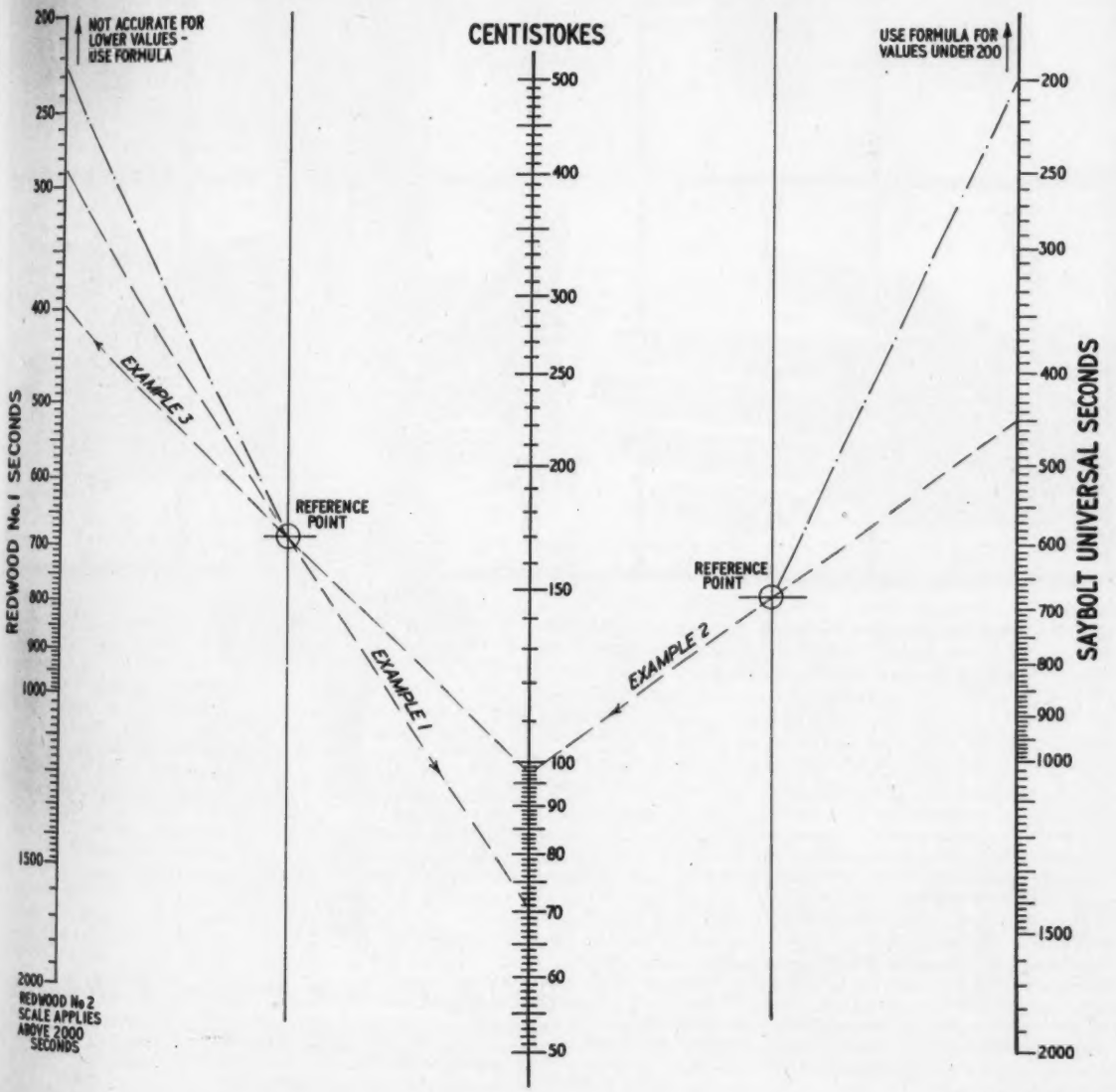
For S.U.S. less than 100 seconds, centistokes = 0.226T − 195/T; for S.U.S. 100-200 seconds, centistokes =0.220T − 135/T, where T is S.U.S. time in seconds.

For conversion of centistokes into engineering units, the following factors apply:—
Kinematic engineering units $in.^2/sec.$ = centistokes × 0.001549; kinematic engineering units $ft.^2/sec.$ = centistokes × 0.00001078.

Example 1. To find the equivalent viscosity in centistokes to 286 seconds. Redwood No. 1:
Project from Redwood scale value through left hand reference point to read centistokes on centre scale.
Answer 70.5 centistokes.

Example 2. To find equivalent viscosity in centistokes to 450 Saybolt Universal seconds:
Project from Saybolt scale through right hand reference point to read centistokes on centre scale.
Answer 97.5 centistokes.

Example 3. To find Redwood No. 1 equivalent of 450 seconds Saybolt (as in example no. 2):
Follow example to find equivalent point on centistokes scale. Project from this point through left hand reference point to cut Redwood No. 1 scale.
Answer 395 Redwood No. 1 seconds.



Data by R. H. Warring

EMD 7401 for further information

UNIT CONSTRUCTION IS THE REASON . . .

Unit construction means that there is a range of 432 standard Baldwin Pneumatic & Hydraulic cylinders in bore sizes of 1½" to 8", together with over 1000 standard control valves. On any machine, whether space is limited or supporting surfaces awkwardly situated, Baldwin fluid power equipment can be fitted quickly, efficiently—from stock! And every Baldwin cylinder will speed production for years of trouble-free service and easy maintenance.

Why? . . . these exclusive Baldwin features ensure RELIABILITY:

- *Polished hard-chrome plated cylinder bores and piston rods.*
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- *Rugged malleable cast iron and steel construction rust and corrosion proof inside and out.*
- *Built-in cushioning to absorb the shock of heavy loads moving at high speeds.*

Superbly finished Control Valves and accessories complete the Baldwin Fluid Power range, operating on air at up to 150 p.s.i. or oil at up to 250 p.s.i.
Baldwin Fluid Power Cylinders can speed *your* production. Write now for the Fluid Power Brochure EMD24/505a or better still call in our Technical Advisory Service, free of all obligation.

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New Books

Mechanical Properties of Structural Materials at Low Temperatures. *A compilation from the literature. (Monograph* 13, *U.S. Department of Commerce, National Bureau of Standards*—$1.50.)

When the engineer is called on to design equipment for operation at very low temperatures, he is faced with a problem: the lack of suitable information on the mechanical properties of commercial materials, in order that he can decide on the most suitable material and the method of stressing for the cryogenic device. The object of this book has been to gather together reliable data of this nature, some of it previously unpublished.

The data is presented in such a way that the engineer who is carrying out these initial calculations can obtain a definite result quickly. The curves in the book represent the mechanical properties as functions of temperature, and not as maximum or minimum values. Thus, the curves appear as stress (p.s.i.), elongation (per cent in 2 in.) and impact energy (ft.lb.), plotted on a temperature (deg.K.) base. This Kelvin temperature scale is so widely used in cryogenics that all the data has been converted to it. But, for the convenience of those who are more accustomed to the Fahrenheit scale, conversion scales are included. These may be cut out and held along the abscissa to allow interpolation as well as direct reading in deg.F.

Most of the information in literature that tells something about the ductility of materials is in the form of tensile elongation or impact data. It is for this reason that these two mechanical properties are given in the graphs, even though they may not be the most satisfactory indications of ductility.

One of the first things that the newcomer to the cryogenics field learns about materials is that some of them are brittle at low temperatures, and thus cannot be used in many structural applications at these low temperatures. There are certain cases, however, where it would be a mistake to apply the ductility criterion in the selection of a material for low temperature service. Springs are an example. The authors are aware of an instance in which the most suitable material for a low temperature coil spring was not considered, because it would be brittle at the service temperature. The ductility criterion should not generally be applied in such cases, since a smooth coil spring, having no re-entrant corners, is carefully designed to act as an elastic member, and usually does not need to be ductile.

This book is well printed and the graphs, which make up most of it, are very easy to read. The book should therefore be most useful to readers who are on the look-out for information on structural materials at low temperatures.

W. L. Morse

Theory of Metal Cutting. *By Paul H. Black. (McGraw-Hill*—58*s.*)

The influence of Professor Black's practical training can be seen in this volume on metal cutting. The background work, from the metallurgical to the mechanical aspects of the process, is covered in an excellent manner. The approach is the logical one of initially considering the structure of the atoms and crystals, thus giving a basic understanding in this important study. In the next chapter, on the mechanics of metal cutting, the author provides a fair assessment of the current mathematical analysis of the forces involved in orthogonal cutting; this is actually the only mathematical content of the book, and, if the reader wishes, it may be by-passed without losing the sense of the book. It is pleasing to find strength of materials introduced into an otherwise production topic.

The basic principles of friction, lubrication and wear are dealt with in an admirable manner and, as with all the work, the reader is gently led through interesting and important paths with deceptive ease and clarity. Cutting tools, fluids and tool wear are the subjects of successive chapters, with a fourth chapter on tool life, its significance and measurement. To fulfil the omnibus nature of the title, the author has included brief yet useful chapters on the grinding of metals and three-dimensional cutting. One interesting and valuable feature is the appendix dealing with visual aid for the action of metal cutting utilising a paraffin block as a work piece.

A truly comprehensive list of references is given (120 in number) to encourage and direct the readers' future study in this subject.

R. H. Pritchard

Mathematics of Engineering Systems. *By D. F. Lawden. (University Paperbacks*—12*s.* 6*d.*)

The appearance of the second edition of this book as a paperback at a very reasonable price is to be welcomed. The book has already established itself as a useful text for electronic and electrical engineers in which the basic mathematical methods are discussed with the utmost clarity. The work is eminently readable, and most of it is comprehensible to the average engineering student.

The author gives an account of the mathematical methods employed to analyse the behaviour of physical systems such as electronic amplifiers and oscillators, servo-mechanisms and regulators. Classical methods of solving differential equations are illustrated by their application to electric circuit theory, with emphasis on the stability of solutions. More modern methods are applied in the treatment of the response of linear systems to standard inputs, and accounts of the Laplace Transform and Fourier Analysis are closely related to practical applications.

The book contains a large number of excellent examples (with answers), for solution by the reader, which in many cases carry a stage further the ideas elaborated in the text. References to a fuller treatment of many topics are given in a bibliography and list of original papers at the end of each chapter.

Two important additions are made in this edition. The first discusses the behaviour of sampling servo-mechanisms in which input and output are connected by linear recurrence relations. These are solved by a method originated by the author comparable to that of the Laplace Transform in the solution of differential equations. The second addition deals with the Fourier analysis of noise (or interference). Ideas of autocorrelation are introduced to discuss its diminution or magnification in passage through a linear system.

Although this book is primarily concerned with oscillations of electrical systems, much of the subject matter will interest mechanical engineers, particularly the chapter on non-linear vibrations.

C. G. Lambe

Materials Selection for Process Plants. *By Russell E. Gackenbach. (Reinhold; Chapman & Hall*—68*s.*)

This is a practical handbook, intended to be of direct use to personnel connected with materials selection for diverse process and chemical plants. The author deals with a very wide range of materials, discussing their corrosion-resisting qualities together with mechanical properties, fabricating characteristics and other features. The basic data for these materials have been derived principally from the material producers' publications, and from technical literature. The information is presented in non-technical terms, easily understandable even by newcomers to corrosion engineering.

The book commences with a discussion of the general aspects of corrosion engineering and related topics. Various corrosion phenomena are then studied, and their basic mechanism explained. This is followed by a chapter on cathodic protection, discussing its principles and various applications. The next chapter studies the role of various inhibitors, and includes a short reference to the relatively new vapour-phase inhibitors. This is followed by a discussion of various design aspects from the point of view of the corrosion engineer. The chapter also contains a list of "rules" for successful design under a variety of conditions.

The next fifteen chapters deal in detail with the relevant properties of individual materials ranging from iron and steel to paints and coatings. Applications for each of these materials are discussed with regard to manufacture, cost, etc. The book concludes with glossaries of corrosion and metallurgical terms.

W. E. Sirk

New Books (cont. from page 619)

Proceedings of the Fourth International Electro Heat Congress. (*Comitato Elettroteanico Italiano* — 35,000 *Italian lira.*)

The complete proceedings of this Congress, which was held in Italy in May 1959, have now been published in two volumes. Volume 1 consists of 300 pages, and contains the programme, a general report of the Congress, all the contributions to the discussions, and a complete index.

Volume 2 has 1,212 pages, and includes in full all the 185 papers presented at the Congress, each being printed in that one of the three official languages (English, French and German) in which it was presented. A summary of the contents of each paper is provided in each of these three languages. The papers range over the whole field of electric process heating, and are divided for convenience into ten sections.

The two volumes contain a wealth of information on electroheat applications and developments up to 1959, and should provide something of interest to all British manufacturers and form a worthy addition to all industrial and technical libraries.

Principles of Manufacturing Materials and Processes. *By James S. Campbell, Jr.* (*McGraw-Hill*—76*s.*)

This work is virtually encyclopaedic in nature, ranging from metallurgy to electro-machining in content. The depth of treatment is sufficient for the undergraduate student requiring an introduction to industrial manufacturing.

The first third of the book gives an excellent and often very detailed description of the basic foundry processes—yet the chapter on metrology, after the introductory chapter, does not seem to be in a logical position. Powder metallurgy and plastics are discussed in a manner which gives the engineering student an appreciation of more recent materials.

The chapter on plastic-flow and mechanical-working is a rather unconventional treatment of the metallurgy and stress analysis found in other texts. A mathematical approach is used, and would be welcomed by a student with a good theoretical background; this is the only topic involving a non-descriptive text and as such may be ignored without irreparable loss. One disappointing facet is the apparently haphazard grouping of the sections on sawing, broaching and gear cutting, which is contrary to the importance of these subjects in modern gear production. The jointing processes are discussed in an informative manner, covering forty pages, including some of the recent methods of joining the less weldable materials. The chapter on milling and similar machining processes covers a far wider scope than is usually included in such a text, and descriptions are given of profiling, duplicating machines and the pantograph linkage, which are valuable additional features appertaining to toolroom work.

The general printing and layout are up to best American standards; most of the diagrams are clear and well notated, while generally the photographs add to the value of the text.

R. H. Pritchard

Automatic and Fluid Transmissions. *By J. G. Giles.* (*Odhams Press Ltd.*—45*s.*)

Mr. Giles says that the object of his book is to record some of the history of automatic and fluid transmissions and to describe the operating principles of the more important of them. He appears to have achieved his objective but only somewhat un-uniformly. Historically his survey is good, but in the descriptions of present-day transmissions he seems to have tried to do too much and the result is not altogether satisfactory.

The first chapter outlines the development of transmissions (i.e. gearboxes and their equivalents) from Levassor's gearbox up to the present, but the treatment is uneven; thus three-quarters of a page are given to a line drawing of Constantinesco's transmission but the description occupies only six lines. Chapter 2 dealing with the design requirements is very well done as also is Chapter 3 on the development of the mechanical gearbox. It is difficult to see, however, why a half-tone illustration of a bevel differential and final drive assembly should be included in the latter. Under the heading Hydraulic Control Systems, Mr. Giles deals with elementary hydraulic principles, types of pump, the fluid operation of clutches and brakes and forms of valve; two examples of complete hydraulic circuits are described.

In Chapter 5, which is entitled Semi-automatic Transmissions the author describes hydraulically, pneumatically and centrifugally operated clutches, the Cotal epicyclic gearbox, and synchromesh mechanisms, all of which are components for use in semi-automatic transmissions rather than transmissions themselves. Some fluid couplings and torque converters are also described but the principles of their operation are not given, but in Chapter 6 many characteristic curves of torque-ratio and efficiency against speed-ratio are given; some of these seem to be a little optimistic. A large number of automatic transmissions which have been, or now are, used in American cars are described rather briefly in Chapter 7. Many of the half-tone illustrations of these are poor; those in Chapter 8 which covers the same ground for European cars are better. The last chapter gives Mr. Giles's ideas on future developments, and here the hydrostatic transmission which was mentioned in Chapter 1 receives more adequate treatment. The last twelve pages are devoted to gas turbines.

Perusal of the book leaves the writer with the impression that it would be greatly improved by a reduction in the number of devices it deals with and an increase in the detailed descriptions given of them. Nevertheless the work is one which anyone who is interested in the subject should find valuable. The paper, printing and production of the book are excellent.

W. Steeds

Review of Progress in Dielectrics, Vol. 3. *Edited by Birks and Hart.* (*Heywood & Co. Ltd.*—63*s.*)

The third volume in this series maintains the original aim of catering for a wide range of readers having a common interest in aspects of dielectric materials and their properties. The present book is however, decidedly more theoretical in the treatment of its subject matter than the previous issues, and it may therefore be somewhat restricted in its appeal. The main theme of four of the six articles included is the weak-field properties of dielectrics. These cover the subject from different aspects: firstly for the physical-chemist there are excellent contributions on the theory of polarisation and relaxation, and the mechanisms of dielectric absorption in both inorganic and organic solids. For both the physicist and the chemist there is an article on the dielectric properties of water in the free and bound states which includes a useful summary of the various microwave techniques for measuring dielectric properties. The last of the four contributions is of more practical interest since it deals with modern developments in the U.S.A. in polymers for cable insulation.

The other two sections deal with the theory of breakdown in solids and dielectric waveguides and aerials. A previous article in Volume 1 has dealt with aspects of breakdown processes in practice, whereas the emphasis in the present instance is on the fundamental theories of thermal and intrinsic breakdown. Considering the growing interest in microwave technology, the contribution on waveguides and aerials is of some general scientific interest. The individual articles are self-contained, well written and cover the subjects in a very adequate manner. Some indeed may be regarded as outstanding scientific contributions in their own right. In all cases they provide good reviews of the present state of progress in the several fields of interest, and all have excellent lists of references. This particular volume could be very useful as an introduction for the student who is specialising in dielectrics.

E. A. D. White

OTHER BOOKS RECEIVED

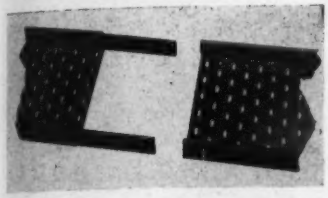
Working Stresses for Structural Laminated Timber. (*H.M.S.O.*—4*s.*)

Contains basic stresses for a variety of timbers, with a realistic evaluation on the effect of knots.

WHAT'S NEW IN MATERIALS

Stronger Cable Trays

As an addition to the standard Admiralty specification cable tray, a new and much stronger pattern to be known as RF.6 has been produced for heavy cable work. The trays differ from previous patterns in that the edge of the trough is formed into a narrow inverted U section. This has the advantage of greatly strengthening the tray, and at the same time facilitates a new and simple system of butt-jointing the trays by the use of special connecting bars which fit within the turned-



over section of the tray edge. These joints are claimed to be neat and very strong.

A further important feature is the wider spacing of the perforations; because less metal is cut away the rigidity of the tray is greatly improved. Tests have shown that fewer perforations do not in any way hamper the work of installing cables, pipes or tubes.

The standard 8-ft. lengths of this new type tray are said to readily withstand loads far in excess of those which would collapse conventional designs. RF.6 plates can safely be used as temporary access catwalks, and are said to eliminate the need for reinforcement under normal conditions.

The trays are available in widths from 6 to 24 in., in 8-ft. lengths, in a variety of surface finishes. There is a complete range of matching tees and bends with suitable coupling pieces. *N. Greening & Sons Ltd.*, P.O. Box 22, Britannia Works, Warrington, Lancashire.

EMD 7483 for further information

Paper-based Laminates

Three new laminates of Swedish manufacture are now available in this country. Quality F.103 is manufactured especially to meet the needs of the British market requiring manufacture to BS 1137 Type 3. It complies strictly to this grade while, in addition, retaining the excellent workability for which Swedish laminates are claimed to excel.

Quality P.6 is designed specially as a commercial type with high electrical performance, but in fact complies with BS 1137 Type 3. It will punch and machine satisfactorily for most operations at ambient temperatures.

Quality Super III is another special British grade manufactured in accordance with BS 1137 Type 1, but said to have properties well in excess of this specification. *Perstorp Products Ltd.*, 157-159 High Street, Orpington, Kent.

EMD 7484 for further information

MoS_2 Grease

Molytherm grease has been designed specially to provide lubrication for industrial plant and machinery at a higher range of temperature than that of other high temperature greases. It is recommended for continuous service above 180 deg. C. and is claimed to withstand long periods above 230 deg. C. and short periods up to 290 deg. C., and to lubricate mechanisms previously lubricated only by silicones. It contains molybdenum disulphide to ensure its lubricating ability.

Based on a high flash point oil and a non-soap thickener which is said to be unaffected by heat or chemicals, the grease is soft enough to be applied through grease cups or nipples. It is also said to be resistant to steam and water, and to show considerable resistance to the stripping action of solvents and vapours. *Rocol Ltd.*, Rocol House, Swillington, nr. Leeds.

EMD 7485 for further information

New Alloy Steel

Commercial production of a new alloy steel designed for service temperatures up to 675 deg. C. has started. Known as Esshete 1250, this austenitic creep-resisting steel is the outcome of five years of research and testing, with the result that unusually comprehensive data is available on its properties and performance. It is a 15% chromium, 10% nickel, 6% manganese steel, the composition including smaller percentages of silicon, molybdenum, vanadium, niobium and boron. It combines a high level of rupture strength with adequate ductility, good weldability, structural stability and oxidation resistance at elevated temperatures for long periods. It also has good manipulation properties. The steel is thus suited for service in power stations of advanced design.

It has proved satisfactory in the production of bars, tubes, pipes and large forgings; sheet trials are in progress. Large bars, pipes and plate can be readily fabricated in either the hot or cold condition, cold forming being understood to include temperatures not exceeding 650 deg. C, and hot forming not less than 900 deg. C. Whichever method of fabrication is adopted, the material requires a re-solution treatment within the range 1,050-1,150 deg. C.

In extensive weldability trials, employing various experimental and commercial electrodes, Esshete 1250 is said to have given excellent results. The structural stability of the steel compares most favourably with other more conventional austenitic steels. Its oxidation resistance has been assessed by a combination of laboratory tests and exposure in an experimental element in a power station for a period of approximately two years. In this case, too, Esshete 1250 has shown similar characteristics compared with other austenitic steels of the same chromium content. *Samuel Fox & Co. Ltd.*, The Mount, Broomhill, Sheffield 10.

EMD 7486 for further information

Mar-aging 18% Ni, Co, Mo Steel

This new steel is claimed to have an outstanding combination of ultra-high strength, good ductility and toughness. These can be developed by the application of an extremely simple heat treatment which does not involve quenching.

A suitable control of finish rolling temperature of heat treatment at about 820 deg.C., followed by air cooling, develops an essentially carbon-free structure of the martensitic type. The steel has good machining characteristics and, in the annealed condition, a 0·2 per cent proof stress of 40-45 t.s.i. and an ultimate tensile strength of 60-65 t.s.i. are obtained.

Hardening is effected by a simple treatment described as "mar-aging" which results in precipitation hardening of the martensitic type structure. This treatment consists of heating for 3 hr. at 450-500 deg.C., following by air cooling. Quenching is not required to develop the optimum mechanical properties even in large section sizes, consequently, the risk of distortion is much reduced.

Preliminary tests have shown that sound, crack-free welds can be produced in fully heat-treated plate by coated-electrode or submerged-arc procedures. Yield strengths of over 100 t.s.i. have been obtained in "mar-aged" welds of matching composition. *International Nickel Co. (Mond) Ltd.*, Thames House, Millbank, London, S.W.1.

EMD 7487 for further information

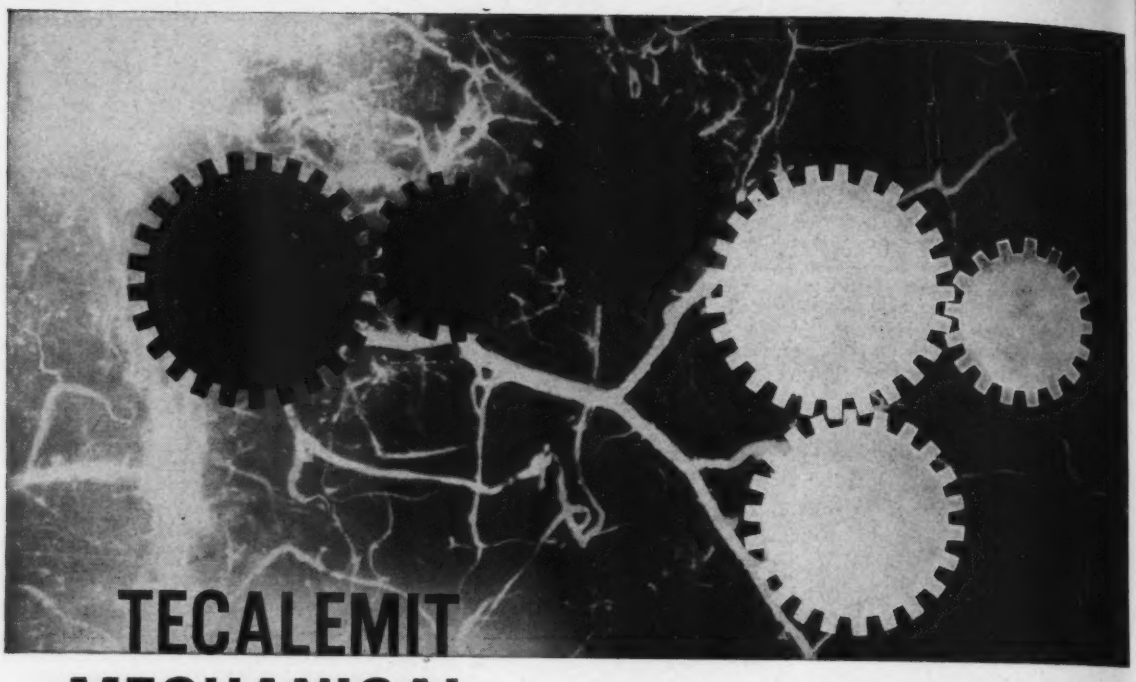
Dough Moulding Compound in Rope Form

An addition to the range of Beetle polyester dough moulding compounds is a general purpose type of Beetle D.M.C. in an extruded rope form, which is shown in the accompanying photograph cut into strips. This material has been developed to facilitate handling during the moulding operation, particularly the loading of multi-impression tools. It should be moulded by the procedure recommended for Beetle D.M.C. Type A.

The standard rope form D.M.C. is beige (natural) in colour. A limited range of other colours is available on request. It is made in nominal diameters of 1 and 1¼ in. of uniform weight per unit length. The bulk factor of rope-form D.M.C. is slightly greater than 1, and it can be stored for three months at room temperature. *B.I.P. Chemicals Ltd.*, Tat Bank House, Oldbury, Birmingham.

EMD 7488 for further information

EMD 7404 for further information



MECHANICAL LUBRICATION —THE BLOOD-STREAM OF A MACHINE

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With Tecalemit Mechanical Lubrication, bearings need no longer be accessible to hand oiling, and there will be no forgotten, neglected or under-oiled bearings to cause costly breakdowns and production hold-ups. Nor is there any danger of messy excess lubricant spoiling products. Tecalemit Mechanical Lubrication Systems provide accurately regulated lubrication to each individual bearing, at the correct intervals.

The BRENTFORD is a fully automatic multiline oiling system, with from one to twenty lines, each with its own independently regulated pump. The unit takes its power from the rotary or reciprocating motion of the machine it serves, or can be supplied with its own electric motor.

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T/714

WHAT'S NEW IN MATERIALS

Pipe Insulation

A new, improved pipe insulation material specially designed to reduce installation costs and for hot, cold and low pressure steam working is now being marketed.

Lightweight, durable and said to be extremely flexible, Foamflex is available in lengths of 9 ft. 9 in. It is off-white in colour and is made in sizes to fit pipes of nominal cores to comply with BS 1387: 1957, from ½ to 4 in.

The depth of cover complies with the requirements of BS 1334: 1959.

Foamflex can be fitted both quickly and easily. The sections are supplied slit longitudinally down one side, and are slipped over the pipe, the joints being sealed with a special adhesive.

The flexibility of the insulation enables it to be carried around slow bends and the material is easily cut to fit bends with sharp internal radii, T junctions, etc. No special fittings are necessary.

Overpainting is not necessary under conditions of normal hot and cold working. Unslit sections are available if required. *Semtex Ltd.*, 19-20 Berners Street, London, W.1.

EMD 7489 for further information

P.v.c. Drainage System

The Terrain roof drainage system is of interest because the components have been designed not as copies of conventional cast iron units, but to take full advantage of the special properties of unplasticised p.v.c. Ten basic units comprise the range, and are said to combine maximum efficiency with minimum cost of erection. Gutter and down pipe is supplied in straight, plain lengths without sockets, thus enabling any length to be cut without wastage of material. Complete rainwater systems may be built up by comparatively unskilled labour, and it is claimed that one man can complete an installation without assistance.

The gutter is 4 in. deep, half round, and has a flow capacity of 11 gall./min. when laid level and 15½ gall./min. when laid to a fall of one inch in 50 ft. The swept configuration of the outlet and the radius of the bends (which conform to the recommendations of the Building Research Station) allow optimum flow. The outlet, together with the down pipe, will accommodate the full capacity of gutters flowing in from each side—approximately 31 gall./min. The gutter is equivalent to 4½-in. standard cast iron, but because of its smoothness and resistance to corrosion, it is claimed to be less liable to flow interruption through sedimentation.

The special design of the Terrain joint support bracket eliminates the need to use mastic in jointing lengths of gutter. Gutter ends are simply inserted into semi-circular slots at each side of the support bracket, where they are securely held. Space within the bracket leaves adequate room for thermal expansion. *Burn Bros. (London) Ltd.*, St. Mary Cray, Orpington, Kent.

EMD 7490 for further information

Zone-refined Tellurium

Zone-refined tellurium of high purity is now available. The total metallic impurity content, excluding selenium, is less than 5 p.p.m., and is normally in the region of 1 p.p.m. The selenium content does not exceed 5 p.p.m. The tellurium is supplied as half-round bar approximately 1 × ½ in. *Johnson, Matthey & Co. Ltd.*, 73-83 Hatton Garden, London, E.C.1.

EMD 7491 for further information

P.t.f.e. Monofilament

Until recently the smallest diameter rod of p.t.f.e. generally available measured about 0·050 in., but now Richard Klinger Ltd. have developed a very fine monofilament of only 0·007 in. dia., which can be woven or knitted into a mesh. This opens up possible applications for filters,

demisters, separators and similar items of equipment at present made of metal. *Richard Klinger Ltd.*, Sidcup, Kent.

EMD 7492 for further information

New Silicone Products

Two new methyl phenyl fluids, named DP 175 and DP 190, have been developed. The presence of phenyl radicles gives these fluids advantage over the standard dimethyl silicone fluids for certain applications. These enhanced qualities include greater heat stability and improved compatability with other materials. The special properties of DP 190 give it importance for employment in high-temperature oil baths, as a high-temperature lubricating oil, and as the basis for high-temperature lubricating grease.

A release resin, R 206, has interesting domestic and industrial applications. Its earlier success, as development product DP 163, has amply justified promotion to the full sales range. Recommended as an effective and long-lasting coating for bread-pans, cake-tins and frying pans, this resin is also an excellent product for treating moulds to ensure easy release of rubber and plastics products, including those formed with epoxy resins.

M 402, a new silicone emulsion for mould release, is now available in quantity. This product gives a more viscous coating to mould surfaces because it is the emulsion of a silicone grease in water. For general mould release applications in the rubber, plastics and metal industries, M 402 can be used in the same way as M 400 and M 401. It is said to be outstanding in applications where a good mould coverage is wanted, as in the manufacture of deep-tread tyres. *Imperial Chemical Industries Ltd.*, Imperial Chemical House, Millbank, London, S.W.1.

EMD 7493 for further information

Glass Reinforced Extrusions

This material has been developed to meet the needs of the electrical industry for glass reinforced epoxy resin extruded sections with high glass content and consequential very high strength (120,000 p.s.i.). Certain grades are said to have outstanding heat resistance (270 deg.C.) combined with the electrical properties characteristic of good quality epoxide materials. This new material has, it is said, already solved critical problems beyond the capacity of polyester-based laminates and extrusions. *Thermotank Plastic Engineering Ltd.*, Chapelhall Industrial Estate, Aidrie, Lanarkshire.

EMD 7494 for further information

Glass Reinforced Filament Tape

Scotch Brand No. 898 glass reinforced filament tape has an acetate backing, and is reinforced with thin filaments of glass. Introduced to meet the need for a strong reinforcing material, it will by virtue of its thinness (only 0·007 in.) and its transparency easily conform to carton shape, at the same time not hiding important sales messages, trade marks, labels and other markings—an important factor where sales appeal is closely linked with packaging.

In addition to these qualities, the tape has a tensile strength of 340 lb. per in. of width, and will reinforce a fully telescoped carton with four ½ × 6 in. tape clips. *Minnesota Mining & Manufacturing Co. Ltd.*, 3M House, Wigmore Street, London, W.1.

EMD 7495 for further information

Strippable Coating

An easily strippable protective vinyl coating, type KP/100, for metal and glass is announced. This material can be applied by brushing, spraying, dipping or flow coating. Used primarily to protect the surface of polished metal or plate glass, it is also suitable as a substitute for strippable tapes in painting and building construction.

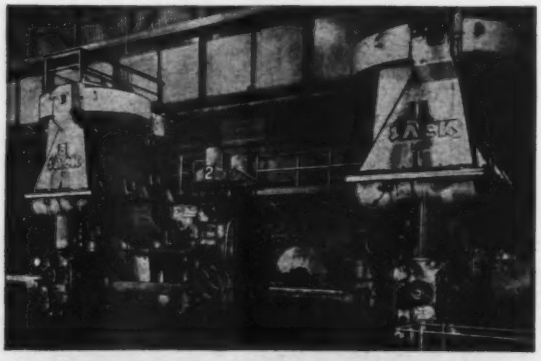
Tough enough to withstand abrasion, KP/100 is highly flexible, and can be stripped off as a continuous film. It is said to be resistant to moisture, common solvents, acids and alkali, oil, detergents, plaster and mortar. Due to its high film strength, it is most economical in use. *Swale Chemicals Ltd.*, 53 Park Hill Road, Croydon, Surrey.

EMD 7496 for further information

*Proved in Operation

TEN TIMES LONGER

than bearings of conventional metals under the most punishing conditions



Think of the saving this entails!—not merely in replacement costs but in production time previously lost through shutdowns. Reduced friction too cuts power consumption by up to 15%, and roll neck wear is also reduced.

At the Irlam works of the Lancashire Steel Manufacturing Company Ltd., Ferobestos bearings and thrust collars are fitted on a 36" "Loewy" reversing roughing mill, and a "Sack" six-stand horizontal and vertical continuous billet mill, illustrated on left.

*Here's the proof

In a typical British Application a set of Ferobestos bearings rolled over 180,000 tons of steel compared with 14,000 tons—the best performance by conventional white metal bearings. Ferobestos Bearings have given equally satisfactory service on many other kinds of rolling mills, among them plate mills up to 12ft, slab mills up to 7ft, section mills up to 36 inch reversing, cold sheet finishing mills and up to 13 high stand mills.

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WHAT'S NEW IN COMPONENTS

Hermetically-sealed Relay

The Microtact hermetically-sealed miniaturised moving coil measuring relay has been introduced to meet the demand for a

smaller sealed version of the Sensitact moving coil measuring relay. This new relay comprises a screened moving coil galvanometer of very small size, of which the moving coil, mounted on shock absorbing supports, is fitted with a moving contact which engages with fixed contacts at either end of the arc of travel. The whole assembly is enclosed in a cylindrical metal container which is mounted on a standard seven-pin miniature-valve type base and hermetically sealed. The complete relay is 40 mm. long, 20 mm. dia. and weighs approximately 1·12 oz.

Response time of the relay is 0·1 to 0·5 sec., depending on the particular model and the positions at which the contacts are set. The power handling capacity of the contacts is 30 milliwatts at a maximum voltage of 20 volts d.c. or a.c. *Leland Instruments Ltd.*, 145 Grosvenor Road, Westminster, London, S.W.1.

EMD 7497 for further information

Elapsed Time Indicator

The Synchronous Hours Counter is fitted with a self-starting synchronous motor, so that the indication is correct even though the "on" periods are of very short duration. The counter is fitted with two 12 in. connecting leads, and is designed to be connected in parallel with the mains connections to the equipment of

which the operating time is being measured.

The counter indicates from 0·1 to 99999·9 hr., and is fitted with six digit drums (the sixth measuring 0·1 hr. intervals). It can be supplied for 100/125 volts a.c., or 200/250 volts a.c., for either 50 or 60 c/s supply. Current consumption on the 200/250 volt, 50 c/s unit is approximately 10 mA.

The counter may be used for measuring the life of electrical equipment, checking the replacement period of electronic valves, planning overhaul programmes for working machinery, and for life-testing prototypes. *Measuring Instruments (Pullin) Ltd.*, Electrin Works, Winchester Street, Acton, London, W.3.

EMD 7498 for further information

Simplified Bonus Clock

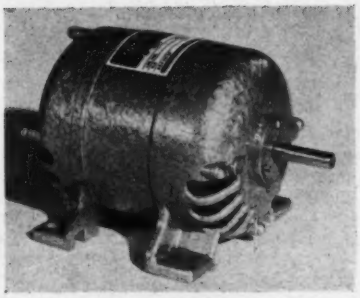
A simpler and cheaper alternative to the original Bonus Clock has been developed. It is also claimed to allow more

productivity with less fatigue, and field trials show increases in output of between 20-40 per cent.

The clock, which is named "Earnie", does not show the actual bonus time and cash earnings, but is designed to tell the operative immediately if he (or she) takes longer over an article than the time to which the dial is set. While working within this time he is encouraged by a green light, but if he exceeds it the green light is replaced by a red light, until he starts on the next item.

Earnie is intended for stepping up the output in high speed repetition work such as sheet-metal pressing, and for keeping "in bonus" operatives who have been trained with a Bonus Clock. The standard unit has a time range from 5 to 60 sec. but it can also be supplied with ranges of 3 to 15 sec., 15 sec. to 4 min., and 30 sec. to 12 min. *Bonus Clocks Ltd.*, 5-7 Church Road, Richmond, Surrey.

EMD 7499 for further information



Fractional Horse-power Motors

Recently introduced is the first of a new range of fractional horse-power motors said to be of advanced design giving a wide range of torque and output speeds. Manufactured to Class E BS 2757 (which allows a temperature rise of 65 deg. C. above ambient), they are known as the GL8 (motor only, shown above), GL9 (motor with single reduction gearbox), and GL10 (motor with double-reduction gearbox). They are available for single and three-phase supplies and for various voltages.

All motors, both induction and commutator type, are supplied as standard for reversing, and at no extra cost, a new design of capacitor can be fitted to the rear end of these motors to make compact, self-contained units—or alternatively the capacitor can be separately mounted in the usual way. They are easily mounted by foot or flange, and are suitable for running in any position, base holes being elongated for final adjustments. The gearboxes can be turned to bring the output shaft into a variety of positions to suit the job on hand, and practically any final output speed can be supplied. All the shafts are ground to a fine limit, and ball journals or plain bearings can be fitted in all frames without dimensional alterations. Unless otherwise specified, all geared units have a ball thrust-journal at the gearbox end. All the bearings are pre-lubricated, giving long, trouble-free life, and the grease used in the gearboxes has been chosen to give a low-viscosity coefficient. "Encapsulated" windings will be available in addition to the normal Class E BS 2757, rendering them impervious to attack by moisture, oil, and most chemicals. Thus, an open drip-proof motor "encapsulated" in this way can often be used in place of a totally enclosed frame, obviating the need for a larger unit. *Comtex Ltd.*, 566 Cable Street, London, E.1.

EMD 7500 for further information

FOR MORE INFORMATION
about any of the products mentioned on these pages, please use the special reply card bound in this issue.

READERS' ADVISORY SERVICE
We shall be pleased to help readers who have difficulty in tracing sources of supply of materials or components.

WHAT'S NEW IN COMPONENTS

Electromagnetic Counter

The Type 1250 lightweight electromagnetic counter has been designed primarily for hot and cold drink dispensing vending machines, though many other applications exist. It is a three figure model with manual preset which enables the counter to be set to a predetermined number and, when pulsed, subtracts to zero whereupon a micro switch either opens or closes a circuit. The cut-out device is so arranged that the unit can be preset at any number between zero and 999.

Models are available for most standard voltages from 24 volts d.c. to 230 volts a.c., and care has been taken in the design to ensure that the unit is unaffected by humid conditions. *Counting Instruments Ltd.*, 5 Elstree Way, Boreham Wood, Herts.

EMD 7501 for further information

Integrating Tachometer

A new 15 integrating motor tachometer, Type 105P2Y, introduced by the Norden Division of United Aircraft Corp., is now available in the U.K. This tachometer has high output-to-null voltage ratios and accurate performance over the extended temperature range 55 to 80 deg. C. Another valuable feature is the instantaneous response attainable, since no warm-up time is required at any temperature within the operating range. The unit uses no heating elements, mechanical thermostats, amplifiers or external heat sources, and as a result has the advantages of increased life, low weight and reduced power drain on the overall system. *Ketay Ltd.*, Eddes House, Eastern Avenue West, Romford, Essex.

EMD 7502 for further information

Signal Lamps

A new range of built-in disposable signal lamp units is announced. Principal feature is simplicity of installation—the complete lamp unit is held in position in a 0·629 in. diameter hole by steel spring plates, so that no screws or retaining nuts are required. Each unit is supplied complete with a built-in neon or incandescent lamp. When effective life is ended, the complete unit may be discarded and a new one inserted.

Three basic types are available, as follows:—(1) The SGF 1717; this unit has been designed to operate in conditions of heat or extreme cold, effectively resisting temperatures as high as 135 deg. C., and is therefore particularly suitable for heating equipment applications such as electric cookers, frying ovens, heat treatment plant, etc. Extremely compact, the SGF 1717 measures only 1·377 in. long and is available in a wide range of lamp colours. The incandescent version is available for 110, 220 or 380 volt operation. Life expectancy of the incandescent version is 5,000 hours. (2) The type SGF 20 signal

lamp is designed to operate in temperatures up to 125 deg. C., the incandescent version being available for 4, 6, 12, 24, 36 and 48 volt operation, and the neon version for 110, 220 and 380 volt operation. (3) The SGF 16 is identical in size and appearance to the SGF 20 but is supplied with a neon lamp only, and is designed to work in temperatures up to 70 deg. C. It is available for 110, 220 and 500 volt operation. *Thorn Electrical Industries Ltd.*, Thorn House, Upper St. Martin's Lane, London, W.C.2.

EMD 7503 for further information

Solid State Logic System

A fully-encapsulated version of the Minilog solid state transistorised logic system for industrial sequencing and control applications has been introduced. It can be applied to both simple and complex logic systems, and is designed to replace relays, stepping switches and similar devices, increasing both speed and reliability of performance. It is completely solid-state, requires no maintenance, and ensures trouble-free operation under stringent environmental conditions.

Two types of Minilog element are available. One has six inputs, giving an "inverted and" function, and drives up to five outputs; the other incorporates an emitter-follower and can drive up to twenty-five inputs. Both are exactly the same size (2·0 × 0·85 × 0·63 in.), and occupy slightly more than one cu. in. of space. They have eleven tinned-copper wire leads, 0·32 in. dia. Transistor power elements can be supplied as top- and bottom-end drivers for actuating solenoids and similar devices up to a maximum of 50 volts, 1 amp. *Elliott-Automation Ltd.*, 34 Portland Place, London, W.1.

EMD 7504 for further information

Relay for Printed Circuits

Mounted on a nylon bobbin, and measuring only 1 in. dia. by 2 in. long less reed ends, this dry reed relay (Type R.03)

weighs approximately 2 oz. It has been designed for printed circuit application, and is fitted with six standard contact prongs. The relay contains one normally open reed. Coils may be specified to requirements with resistances up to 20K ohms, and while a nominal power of 0·06 watts is required the relay will operate efficiently at 0·048 watts.

The R.03 is d.c. operated, and has a high life expectancy (20×10^6 operations at maximum contact rating) and a contact resistance of 0·030 ohms. *B. & R. Relays Ltd.*, Temple Fields, Harlow, Essex.

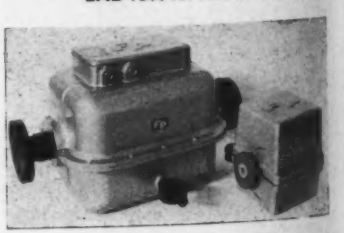
EMD 7505 for further information

Electromagnetic Flowmeter

A low conductivity electromagnetic flowmeter system which considerably extends the range of applications on which this type of flowmeter may be used has been developed. Hitherto it has been impossible to use magnetic flowmeters for handling fluids with a conductivity of less than 20 micromhos-cm., but with the introduction of certain design changes magnetic flowmetering system will handle liquids and slurries with a conductivity as low as 0·1 micromhos-cm. This means that the rate of flow of fluids not far removed from pure hydrocarbons can now be accurately determined.

The meter is said to be obstructionless, accurate, simple, rugged, bi-directional and unaffected by changes in viscosity or density. *Fischer & Porter Ltd.*, Workington, Cumberland.

EMD 7506 for further information



WHAT'S NEW IN COMPONENTS

Electronic Timer

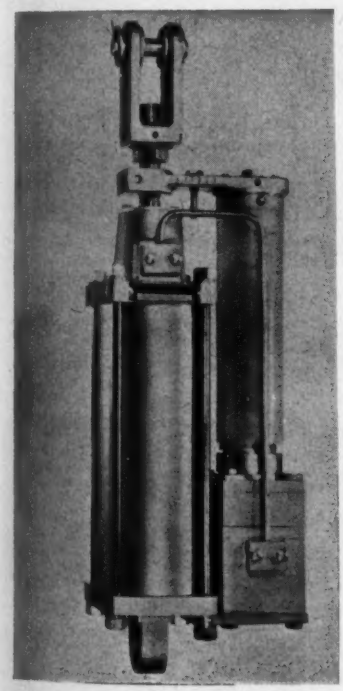
The electronic timer type TY is of robust construction, and covers a wide field of industrial applications. Although inexpensive, it is said to have a high degree of accuracy which meets most of the usual requirements. All components employed are rated very generously, so that a long trouble-free life may be expected.

The timer is available in three forms: (a) in a steel case suitable for wall mounting (units are normally supplied in this form, unless otherwise specified); (b) in a steel case suitable for bench mounting; and (c) on a steel front panel without cover, suitable for flush mounting on the front of control panels or consoles, etc. The dial on the front is engraved and calibrated in actual time. Connections are made to a shrouded terminal block fitted on the front panel. The essential components are a multi-tapped input transformer, a Thyratron, and a timing condenser and resistance. Two relays are included which enable a multiplicity of switching sequences to be obtained. *Londex Ltd.*, Anerley Works, 207 Anerley Road, London, S.E.20.

EMD 7507 for further information

Pneumatic Power Positioner

A small pneumatic power positioner capable of controlling unbalanced loads of up to 150 lb. is now available in the U.K. This positioner is designed to drive valves, dampers and other control devices in any conditions, and has an accuracy rating of ±1 per cent. With 100 lb. air pressure under no load the positioner requires 1·5 sec. to complete a stroke movement. Frequency response of the unit with no load at 10 per cent peak to peak input signal is 1·3 c/s. At 5 per cent peak to peak, frequency response is 0·5 c/s.

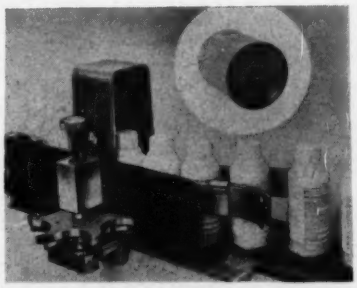


Its small size makes the unit particularly suitable for use by butterfly valve manufacturers, and other original equipment manufacturers who require simplicity of installation, low initial cost and no-maintenance operation. *Hagan Controls Ltd.*, 14 Grosvenor Place, London, S.W.1.

EMD 7508 for further information

Can Coder

The Sideline Markocoder is a new coding device for attaching to any conveyor line handling aerosols or cans, or



any basically cylindrical container. It is unusually simple, inexpensive and compact, and is said to be easy to install, requiring only four screws to attach it to a conveyor. It is driven by the product stream, and operates at any line rate up to 150 units per min. It can imprint code dates, lot numbers, prices or other information in letters or figures or both, on flush, recessed, flat or concaved bottom surfaces.

Since the coder is driven by the stream of products through it, and has no electrical components, it is ideally suited to factory areas where there is some risk of explosion, or where there is a lot of moisture. Quick-drying inks are available for metal, plastics and other non-absorbent surfaces, or for paper board. Sets of parts may be obtained to enable the machine to handle more than one size of container, and an Easi-Lock type can be used for quick changes. *Mark-O-Print Ltd.*, Station Path, Putney Bridge Station, Fulham, London, S.W.6.

EMD 7509 for further information

Self-priming Pumps

The illustration shows the flange-mounted model from the new S.D.S. series of compact Mono-Radial pumps. These units are self-priming, with a normal running speed of 1,500 r.p.m. Capacities range from 1·8 to 5·4 g.p.m. at pressures up to 6,000 p.s.i. The S.D.S. series is suitable for both foot and flange mounting.

Modifications include alterations to the geometry of the pumping chamber, and the inclusion of a new suction valve and shaft assembly. This streamlining has resulted in increased volumetric efficiency, a reduction in overall dimensions, improved performance and increased capacities at lower cost. These new design features will be applied throughout the range of Mono-Radial pumps scheduled for future production. *Andrew Fraser & Co. Ltd.*, Westminster, London.

EMD 7510 for further information

Ebonite Water Meter

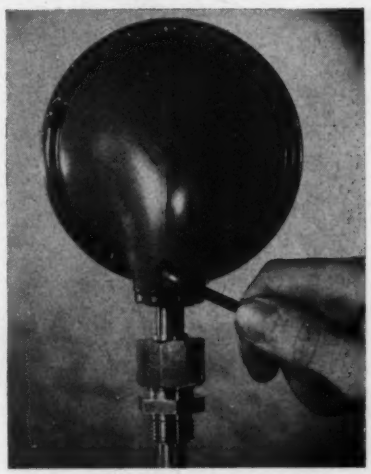
An ebonite working chamber version of the brass ¾-in. JSM domestic water meter has been introduced. This new meter, which is to be known as the Kent ¾-in. SM, incorporates all the features of the JSM improved rotary piston type meter, and may be used where the water supply tends to be corrosive. Both piston and working chamber are of ebonite, and will provide long life without loss of performance or accuracy. It is expected that ½-in. and 1-in. versions will be introduced later.

All international standard body lengths and end-threads can be accommodated. Registration may be in gallons or cubic metres. *George Kent Ltd.*, Luton, Beds.

EMD 7511 for further information

Simplified Thermometer Calibration

Zero Re-set is the first British bi-metal thermometer specially designed so that it can be re-calibrated without calling in a skilled technician. The re-calibration procedure is simple. At the lower back of the vertical head of the thermometer is a countersunk instrument screw. After removing this screw, two turns of a 2 BA Allen key loosens the locking screw and



allows the thermometer stem to be rotated. This rotation moves the pointer and allows adjustments of up to 50 per cent of the scale range. A stop is incorporated in the locking device which makes it impossible to damage the instrument.

The thermometer is at present available with 2½, 4 and 7 in. dials in the vertical pattern in all standard temperature ranges. Horizontal patterns of this thermometer will be available shortly. *British Rototherm Co. Ltd.*, Merton Abbey, London, S.W.19. **EMD 7512** for further information

EMD 7406 for further information·

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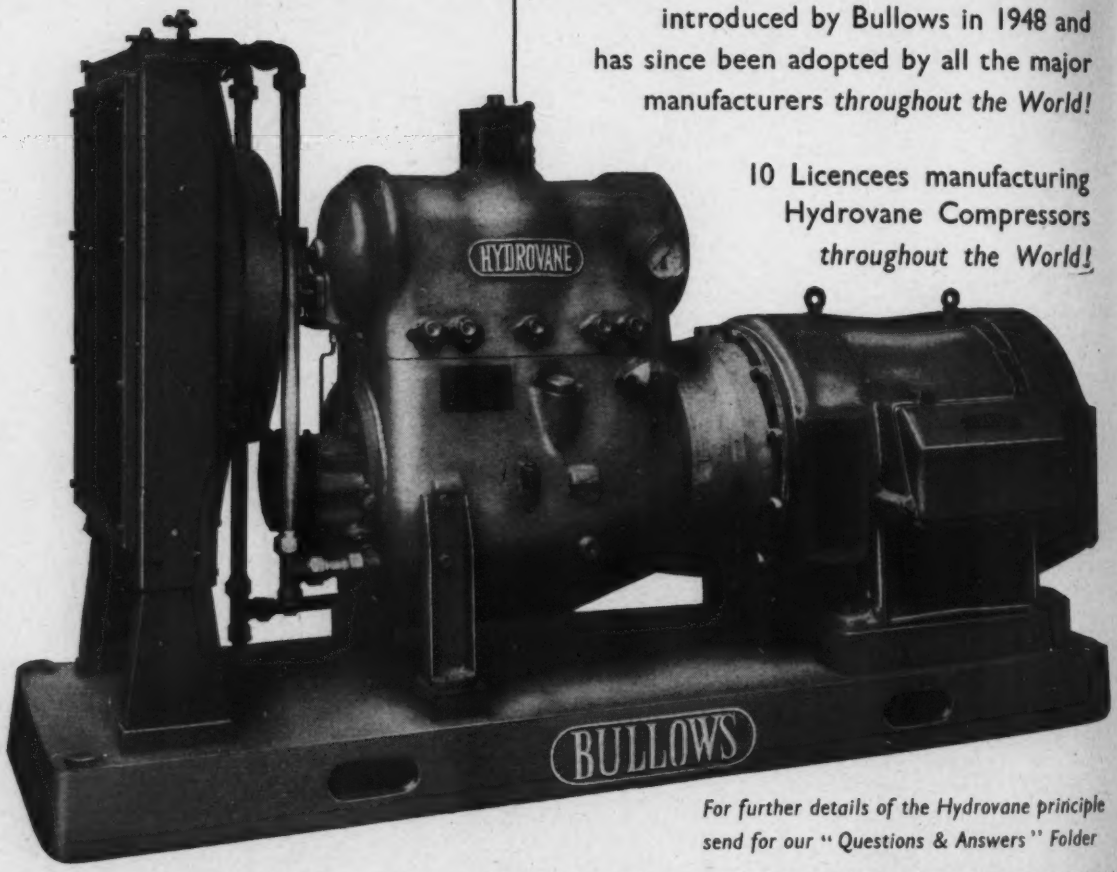

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WHAT'S NEW IN COMPONENTS

Simple Feed Unit for Hopper

A simple device that can be applied and fitted to machines in almost every trade and industry where granulated and free

flowing powders and similar materials are being processed, consists of a hopper which can be placed on the floor or any convenient point for accepting raw material from the bulk source and a large-bore flexible pipe which is fed into the machine hopper, which will normally be some height from the ground and is usually on top of the machine it serves.

Operation is by compressed air working at a pressure of 60 p.s.i., which will raise approximately 25 lb. from floor level to an elevation of 7 ft.; capacity increases with the air speed. One of the big advantages to be gained by use of this feed unit is that it prevents ingress of metallic particles that would be large enough to do damage to extrusion or similar type processing systems. *Amigo Machine Co. Ltd.*, Skylon House, Park Royal Road, N.W.10.

EMD 7513 for further information

Computerised Strain Gauge

The BLH stress-strain gauge now available in this country is a bonded resistance foil type strain gauge with electrical response proportional to either stress or strain at the discretion of the user.

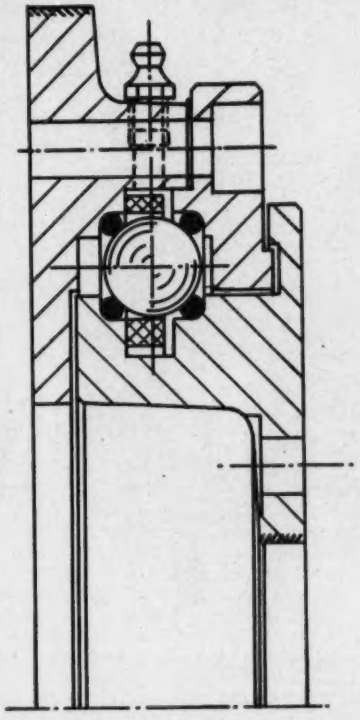
This stress measuring gauge may be regarded as an automatic computer which solves the general stress-strain equations, rejects the axial component of strain due to stress in a transverse direction and responds only to that component of strain produced by stress in the axial direction.

The gauge is designed with two single axial strain sensing elements oriented at 90° to each other and having a common connection so that either of the two elements may be observed independently for conventional strain measurement or together to produce readings that are proportional to stress along the principal gauge axis. By suitable switching arrangements of the three wire lead system provided, it is possible to measure stress or strain along the principal sensing axis and to measure strain along the axis at right angles. *L. Brooke Edwards*, 25 Palmeira Avenue, Hove 3, Sussex.

EMD 7514 for further information

Wire-race Precision Bearings

A new range of inexpensive precision bearings in six sizes of 18 to 40 in. diameter is announced. Specially rolled flanged ring sections of medium carbon steel are used, similar to those used for slewing rings, but the ball races, instead of being flame hardened on the base metal, consist of high grade spring steel wires with spherically ground tracks, inserted in accurately machined grooves. This provides an inherently rigid construction with four lines of contact (see illustration) and accuracies of the order 0·002 in. radial and axial runout can be maintained. A conventional housing is not required, the bearings being mounted by

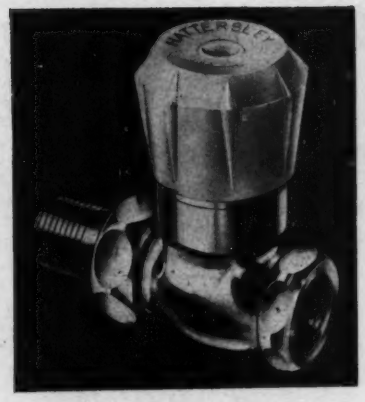


bolting through the flanges to a machined surface. *Roballo Engineering Co. Ltd.*, 43 Dover Street, London, W.1.

EMD 7515 for further information

Valves for Hot Water Systems

A new range of radiator valves in sizes from ¾ in. to 1 in. in both straight and angles designs, for use on all low and medium pressure hot water heating systems up to 150 p.s.i. and 120 deg. C. has been announced. The valves will be known as the Hattersley Delflo range and feature streamlined, compact new handwheels and lockshields in



ivory coloured Delrin. The glands are permanently packed with p.t.f.e. impregnated asbestos.

The valves have bodies and tail pipes in cast bronze and can be supplied natural casting finish, polished or chromium-plated. Careful design ensures minimum flow resistance for both straight and angle patterns. The angle pattern feature spherically seated discs for proportional flow control and both angle and straight designs back seat in the full open position. In the ½- and ¾-in. sizes the angle design will also be available with compression joint for BS 659 copper tube. *Hattersley (Ormskirk) Ltd.*, Ormskirk, Lancs.

EMD 7516 for further information

Shaft Speed Transducer

It is sometimes desirable to measure the speed of a rotating member without actually applying a load which might alter the speed of rotation (e.g. a mechanical tachometer), or where no physical connection is possible. This transducer has been designed for use under such circumstances. It has no moving parts to wear out, and the whole of the unit is encapsulated in epoxy resin.

The unit consists of a polarised electromagnet assembly with a large air gap. The poles of the electromagnet are mounted close to the rotating shaft so that any irregularity of ferrous material (i.e. bolt head, keyway, etc.) changes the reluctance of the air gap. This change causes a pulse in the output circuit. The output pulses can be fed into any suitable electronic counter with or without amplification as necessary. By choosing the correct number of gear teeth and using a time gated counter, the transducer can be used as a direct reading tachometer. *Ericsson Telephones Ltd.*, Beeston, Nottingham.

EMD 7517 for further information

Please Note!

We receive many reader enquiry cards on which the reader has omitted to fill in his name and address. In order to avoid disappointment we remind readers that names and addresses should be included on each card.

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WHAT'S NEW IN EQUIPMENT

Automatic Wire Stripper

Two new series of wire strippers are announced. The Standard Model is for normal commercial use and will strip wire clean up to ¼ in. long. An automatic device holds the jaws open without crushing. Practically all nicking, cutting or fraying is said to be eliminated. This new tool is especially suitable for production stripping of lighter gauge wires, automatic wiring, radio and instrument wires and cables and telephone wiring. The blades of the new wire stripper are easily changed and the complete tool weighs only 14 oz.

The De-luxe model has been designed for use on aircraft and guided weapon cables and similar high quality precision work. The unique blade construction and extreme holding power of the broad jaws are said to permit fast, accurate stripping. This new de-luxe tool has been designed to strip without nicking or scraping wire and without marking insulation. Like the Standard Model, the De-luxe version weighs only 14 oz. *Hellermann Ltd., Bowthorpe Electric Co. Ltd.*, Crawley, Sussex.

EMD 7518 for further information

Shore Hardness Testers

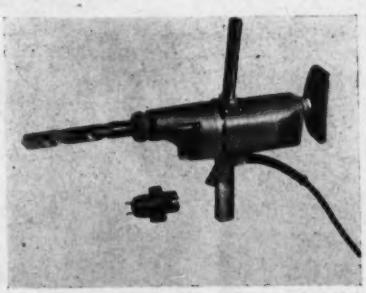
The new Shore Scleroscope Model C.2, is an improved, direct-reading instrument, simple and fast in use for the testing of thin metal sheets such as hardened steel (from 0·006 in. thickness), cold rolled unannealed brass and steel (from 0·010 in.), and annealed sheets (from 0·015 in. thickness). It is also suitable for the testing of chilled iron, forged rolls, gears, axles and other machined parts. The great advantage for industrial production, particularly where finished polished surfaces are concerned, is that the diamond hammer used leaves no impression visible to the naked eye even on strip with a mirror finish. Conversely, tests can be carried out on unpolished surfaces, which is not possible by certain other hardness testing methods. This model may be used freehand, and a conversion table to Brinell and Rockwell C scales is available.

The Model D Scleroscope substitutes a dial and pointer for the reading of hardness numbers instead of the vertical scale behind the hammer tube. The dial, being also graduated in Brinell and Rockwell C hardness numbers, facilitates direct reading in any of the three scales desired. It will test all the materials for which the Model C.2 is suitable, such as razor blades, large die blocks, shafting, crankshafts, machine tool ways and railway wagon wheels. It is not recommended, however, for use freehand. It is said that one operator can make over 1,000 tests per hr. on a quick-moving production line—five times as fast as the speediest competitive device. *Griffin & George Ltd.*, Ealing Road, Alperton, Wembley, Middlesex.

EMD 7519 for further information

Power Drills

A new range of two-speed drills is now being introduced. The range, which has a large power reserve, is doubly insulated and fully earthed to ensure complete operational safety, and is equipped with radio and T.V. suppressors. With a gear box giving two speeds the power tools can operate on all types of materials while possessing far greater "drill bit" life. The range covers from ¼ up to 1¼ in., the P322 1¼ in. capacity unit, for example, having a low speed of 156 r.p.m. on load and a high speed of 280 r.p.m. on load; its nett weight is only 22 lb.—this is said to make it one of the lightest and most compact units in the world.



The light weight eliminates operator fatigue, while increasing the uses of the drill, and makes it ideal for site work. Yet in spite of the low weight which has been achieved, the drills are so designed that they stand up to greater stress and usage than the heavier and conventional models. Together with these unique power drills, a full range of industrial tools in this new Peugeot design has also been developed. *Melbro Machine Tools Ltd.*, 2a Alexandra Road, Manchester 15.

EMD 7520 for further information

Nameplate Machine

Engineering firms can now, it is said, produce permanent images on metal plates in a matter of minutes for instruction panels with half-tone and continuous tone illustrations, circuit and wiring diagrams or straight-forward nameplates. The use of the Vari-Typer Headliner type-composing machine in combination with the new Metalphoto nameplate process gives a complete nameplate service within the same organisation. This means that nameplates for equipment of every kind can now be quickly produced at low cost.

The Vari-Typer Headliner produces high quality composition in hundreds of different sizes and styles of type. It is said to be very simple and fast to operate, to give automatic horizontal letter spacing and automatic development and to give professional typesetting photographically with very low production costs. Where lithographic equipment is available, the Headliner copy can be set on paper, or the film positive itself can be used to make a reverse plate; again, the Headliner film positive can be used to make contact positives. Enlargements and reductions of Headliner type can be made readily because the machine is precision-built to give absolute accuracy and sharpness. *R. H. Lighting Ltd.*, Cobham, Surrey.

EMD 7521 for further information

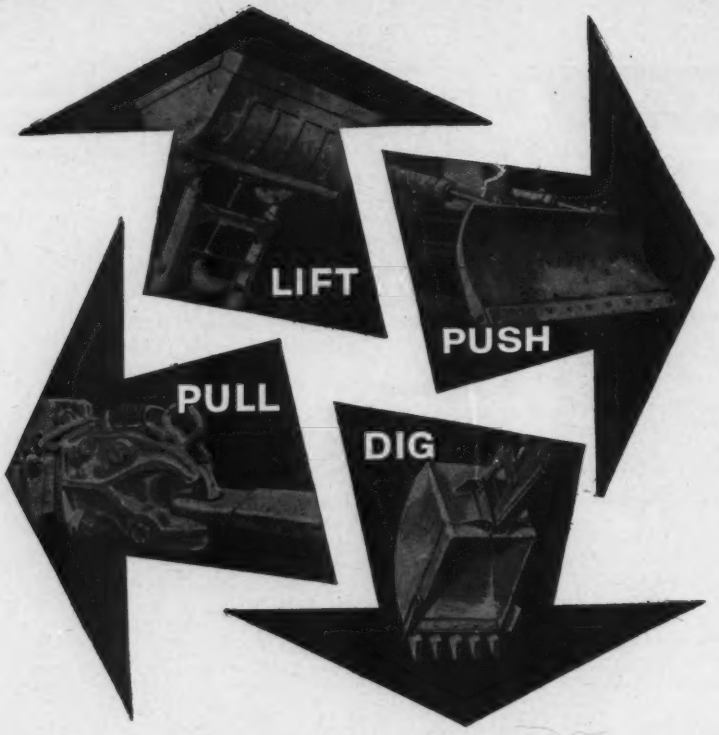
Vapour Peening Machine

In this new machine a unique vapour blast effect is achieved by compressed air without any mechanical assistance. There is no pumping device included in the design and the glass bead slurry is atomised by the venturi action in the hand gun.

The air is turned on to the hand gun by the operation of a foot control valve conveniently situated on the base of the machine, so that operator's hands are left completely free for manipulating the hand gun and components. This is the only manual control the operator is concerned with during the vapour blasting operation.

This tank is designed for one imperial gallon water capacity with 4 lb. of glass beads. It incorporates built-in agitating device to ensure that the glass beads are held in suspension for immediate delivery to the hand gun. Maximum work space is 28 in. wide × 35 in. long × 28 in high. The overall dimensions of the machine are: length 36 in.; width 30 in.; and height 72 in.—excluding extract fan and cyclone separator. *Magnus Chemicals Co. Ltd.*, Salisbury Road Industrial Estate, Uxbridge, Middlesex.

EMD 7522 for further information



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6th Gear	1.04 : 1	2.53 : 1
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WHAT'S NEW IN THE OFFICE

Photographic Typesetter

The fully automated FotoRex is a photographic typesetter that has been designed to serve not only professional printers, art studios, etc., but also the large category of individuals and establishments who require rapid and low cost type setting with a minimum of investment. It is said to be suitable for those who have no art and layout experience, and no knowledge of photo processes and darkroom developing.

The new FotoRex model 311 sets display headlines and body text photographically. Composition is ready for paste-up in a few minutes and the paste-ups can be reproduced by all printing processes including electronic stencils for mimeographing. *Holbro Co. Ltd.*, 41 Brecknock Road, London, N.7

EMD 7523 for further information

Drawing Machine

The Zucor drawing machine won the Gold Medal and Oscar at the 8th International Fair of Inventors at Brussels in 1959. It is a revolutionary design which is patented throughout the world, and is claimed to have many advantages over the normal type of machine.

It combines in one machine the advantages of a drafting machine and those of a parallel ruler, while omitting the traditional parallelogram type with its many fragile joints. A guide rail, easily fixed to the top of the drawing board, guarantees a precision and exceptional parallelism on all parts of the board as well as a precise adjustment.

The ease and the mobility of the group which is in perfect equilibrium means that movements of the travelling carriage take place without any effort. The light is always at the central point of working, being fixed to the moving carriage. The whole machine can be instantaneously pushed back past the end of the board, completely clearing the working area. The group can be easily turned over allowing the place of working to be completely disengaged.

The Zucor, with twenty-five ball bearings, glides over steel guide rails specially treated and calibrated, and is constructed and mounted with great care and precision. This extremely robust design ensures absolute parallelism and ease of use. It can be fitted to any drawing board. The Zucor is made in different models for all sizes from 2 ft. 7 in. x 3 ft. 11 in. to 4 ft. 11 in. x 39 ft. 4 in. *The Intercontinental Export & Import Co. Ltd.*, Gaunts End, Elsenham, Bishop's Stortford, Herts.

EMD 7524 for further information

Rotary Copier

Combining a number of features not found in other "transfer" photocopiers, the new Contouramatic Seal-Pak is claimed to represent a real advance in copying convenience, speed and economy. When the machine is switched on, the developing tank fills automatically. Likewise, the tank empties automatically when the machine is switched off. This device reduces developer oxidisation to the minimum and ensures that the machine is immediately available for making copies whenever needed.

The developer is stored in an expendable Seal-Pak plastics bag, easily removed and changed. A socket in the back of the Contouramatic provides for a Contoura Portable to be included in the same circuit and used for copying pages in periodicals, books, ledgers or anything bulky.

Paper dispensers are built into the base of the machine. A speed of two copies per min. with "Slow" negative paper is said to be easily maintained with single-sheet originals. *Contoura Photocopying Ltd.*, 52a Cromwell Road, London, S.W.7.

EMD 7525 for further information

New Publications and Technical Literature

Nylonic Engineering Co. Ltd.: 44-page booklet entitled "Industrial Plastic Materials", dealing with nylon, polyacetal, polycarbonate and polypropylene in various forms and shapes. 311b Rayners Lane, Pinner, Middlesex.

EMD 7526

Brook Motors Ltd.: 16-page booklet (list 929) for the electric motor user, giving help in obtaining the correct type of motor for any specific purpose. Empress Works, Huddersfield.

EMD 7527

Hellerman Ltd.: 28-page well-produced brochure giving details of the firm's standard range of strap handles. Each handle is illustrated with a full-size drawing. Gatwick Road, Crawley, Sussex.

EMD 7528

Crane Packing Ltd.: Two leaflets (Nos. 7 and 18) describing the company's mechanical shaft seals (types 1A, 2 and 109). Slough, Bucks.

EMD 7529

Glacier Metal Co. Ltd.: 28-page "Designer's Handbook No. 4", on the firm's half bearings and thrust washers. Alperton, Wembley, Middlesex.

EMD 7530

Tin Research Institute: 44-page booklet of data, entitled "The Properties of Tin Alloys". Fraser Road, Greenford, Middlesex.

EMD 7531

Department of Scientific and Industrial Research: "Instruments in the Factory", a 12-page booklet showing how simple instruments can raise efficiency, reduce stoppages, and effect economies in raw materials. Charles House, 5-11 Regent Street, London, S.W.1.

EMD 7532

Hot Dip Galvanizers Association. 8-page booklet on the corrosion resistance of galvanized coatings. 34 Berkeley Square, London, W.1.

EMD 7533

MacReady's Metal Co. Ltd.: 163-page booklet describing the firm's standard range of steels, and other metals. Usaspead Corner, Pentonville Road, London, N.1.

EMD 7534

Pioneer Oilsealing & Moulding Co. Ltd.: 56-page well-illustrated catalogue of the company's range of fluid seals. Cottontree Works, Colne, Lancashire.

EMD 7535

Hall & Pickles Ltd.: "Hydra Products", a 16-page brochure of data on the firm's range of steels and special-purpose wire. Hydra Works, Ecclesfield, Sheffield.

EMD 7536

Associated Lead Manufacturers Ltd.: "Lead Applications to Modern Industry", a 12-page reprint of a paper by Mr. E. R. Newson, covering the use of lead in both the chemical industry and the nuclear field. Clements House, 14 Gresham Street, London, E.C.2.

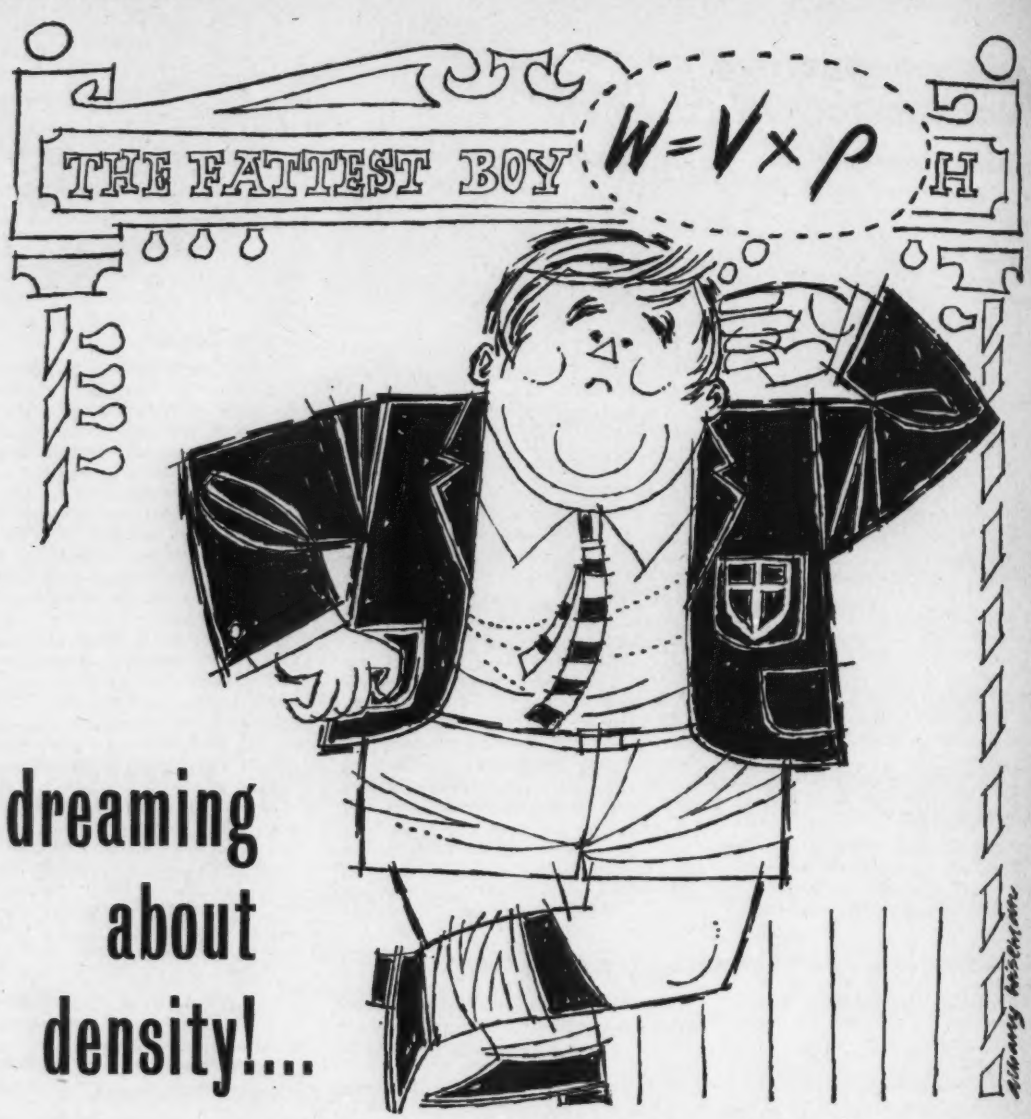
EMD 7537

Henry Wiggin & Co. Ltd.: "The Properties and Applications of K Monel Heat-treatable Corrosion-resisting Alloy", a 16-page brochure consisting mainly of charts and graphs on the physical and mechanical properties of the alloy, with sections on the available forms and applications. Thames House, Millbank, London, S.W.1.

EMD 7538

Lawes Rabjohns Ltd.: Introducing a service for technical students, have produced a comprehensive brochure of students' drawing office equipment. Abbey House, Victoria Street, London, S.W.1.

EMD 7539



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NEWS OF INDUSTRY

Quench Furnace

A *Metalectric* Unicarb sealed quench furnace recently installed at the *Ford Motor Co. Ltd.* incorporates open-type electric heating elements which have been developed for use in carburising atmospheres. These elements working on a low voltage have a special coating which enables them to withstand the carburising action of the furnace atmosphere, and are unique in that they are developed from the conventional strip element material and are extremely simple to install. Their use facilitates a high electrical rating, and the extremely fast heating time with short cycle carbo-nitriding enables a much greater throughput to be achieved for a given furnace volume.

Textile Machinery Research

The *Council for Scientific and Industrial Research* has asked its economics committee to carry out a study of research and development in the field of textile machinery. The purpose of these studies, which are to be made with the collaboration of the industries concerned, is to help the Council allocate the resources for research and development which the Government puts at their disposal, so as to achieve the maximum benefit to the national economy. The textile industry is providing full facilities for this study through the *Textile Machinery and Accessory Manufacturers' Association*. It is expected that the work will take about a year, and that the conclusions will eventually be published.

Trawler Design

Twenty diesel-engined middle-distance trawlers of the latest design are to be built for Welsh Fisheries Ltd., a new Milford Haven company, by the *Atlantic Shipbuilding Co. Ltd.* of Newport, as part of a comprehensive plan to revitalise the Welsh fishing industry. The main engine in each vessel will be a turbocharged *Mirrlees* type KLSSDM six-cylinder four-stroke diesel developing 875 b.h.p. at 230 r.p.m. The trawl winch generator will be powered by a 262 b.h.p. Mirrlees type TLA five-cylinder four-stroke diesel. Electrical power for the windlass, steering gear and accommodation heating will be provided by two 35-kW. *National McLaren* diesel generators.

By phasing their programme, Welsh Fisheries will be able to take advantage of future improvements in fishing techniques and trawler design. The first four ships will be designed for conventional side-fishing, but the hull design, which has been successfully tested at the National Physical Laboratory, will permit alternative arrangements if stern fishing becomes more widely adopted. The trawlers will be all-welded, each vessel being built in seven sub-assemblies, and will have a registered length of approximately 121 ft. 5 in., a length overall of 131 ft. and a moulded breadth of 26 ft. 6 in.

Grease Plant

A new grease-making plant is nearing completion at the Dronfield works of *R. D. Nicol & Co. Ltd.*, a member of the Staveley Group of companies. It consists of the latest design of dowtherm high-temperature electrically-heated pressure autoclave, which with its auxiliary special-purpose pumps and homogeniser, is being installed in an extension of the existing grease shop. The new plant will speed production of existing high-quality greases, and will also enable full-scale manufacture of the latest laboratory developments to take place.

Nuclear Engineering

Three well known industrial concerns, *Imperial Chemical Industries Ltd.* (*Metals Division*), *Rolls Royce Ltd.* and the *Rio Tinto Co. Ltd.*, have jointly formed a new company called *Nuclear Developments Ltd.*, to operate in the field of civil and nuclear engineering. Each of the participants has, in addition to wide technical resources and skills, experience which will be appropriate to the future role of the new company in nuclear engineering.

Design Awards

Among those honoured by the *Royal Aeronautical Society* with some of its highest awards this year are designers of aircraft, engines and navigation equipment, including two pilots and a Frenchman. These awards will be presented at the annual Wilbur Wright Memorial Lecture, one of the most important in aeronautics, which will be given this year on September 12 during the Eighth Anglo-American Aeronautical Conference. Among recipients of awards are Raoul Hafner, for outstanding work on rotary wing aircraft; Dr. Hooker, for practical achievement in aero engine design; and Pierre Satre, of Sud-Aviation, for his work on rear engine configuration aircraft.

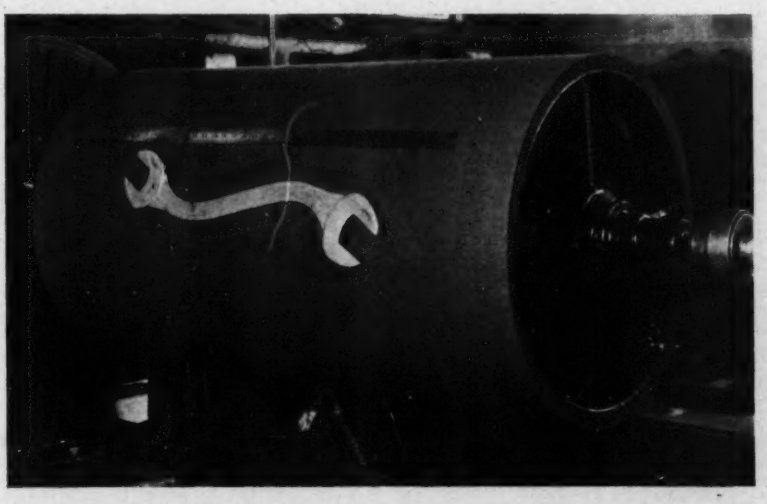
Russian Order

The first Russian order for aircraft flight instruments of Western manufacture has recently been placed with *Smiths Aircraft Instruments Ltd.* by the Russian foreign trading organisation. The order is for forty-five Kelvin Hughes 50,000 ft. altimeters, to be installed in those aircraft of the Soviet airline Aeroflot which operate on routes through and into Western European countries. These units will be fitted in addition to the existing Russian altimeters, on which the altitude readings and barometric settings are indicated in metres, and millimetres of mercury, respectively. The Kelvin Hughes altimeters show altitude in ft., and barometric settings in millibars.

Magnetic Rubber

It is only comparatively recently that the use and manufacture of magnets has become refined, and results accurately predictable. This has permitted their widespread application in many fields. Developments of new materials have enabled large values of magnetism to be developed by relatively small pieces, and has enlarged the handling system field, as well as many other applications.

One successful use of magnetic rubber has been for roll covering (by *Denman Rubber Manufacturing Co.*, U.S.A.). In this case, a steel roll is rubber covered with the material in much the same fashion as a conventional or synthetic rubber roll, the use of which is widely known in the steel and strip-handling industry. The result is a relatively lightweight non-marking magnetic roller, having a broad, low powered magnetic field. Even though the roll face on a large roll will have high points of attraction, these are relatively close together, and the resulting effect is a roll which has almost constant attraction across its entire face. The holding power of such a roll is illustrated below.



Bearing Plant for U.S.S.R.

The Glacier Metal Co. Ltd. recently received a Russian government contract valued at over £400,000 for a plant to make their new tin aluminium bearings. Developed in association with the *Tin Research Institute*, and known as reticular-tin aluminium, they combine high load-carrying capacity with moderate cost, and in 1959 sets of these bearings for tests were ordered by the U.S.S.R. Trade Delegation. In consequence, it has now been decided to standardise this material on two differing Soviet heavy truck engines and also on two private car engines, the design of which is being modified so as to take full advantage of the new material in the development of greater power. It is planned to make these bearings in Russia on plant designed and built by Glacier in England and exported within the next two years.

Combustion Engine Congress

The sixth *International Congress on Combustion Engines* (*C.I.M.A.C.*) will be held in Copenhagen from June 18 to 23, 1962. Plans include six double technical sessions, and three works visits sponsored by Burmeister & Wayne, Elsinore Shipyard, and Kockums of Malmo, Sweden. The theme for the Congress is: "Recent developments with diesel engines and gas turbines above 3,000 h.p. per engine, and gas engines above 1,500 h.p. per engine".

U.S. Company for Belgium

Roller gear drives and machines made by the *Ferguson Machine Corp.* of St. Louis, U.S.A., will soon be manufactured in Europe by the *Ferguson Machine Co. of Belgium* (c/o Brumeca, 66 Bd. de L'Imperatrice, Brussels, 1). An engineering service is available now for assisting in solving high-speed production problems, and for quotations. A field engineer will shortly be visiting the U.K. The new organisation is also backed by the Société Générale de Belgique and its subsidiary La Brugeoise et Nivelles.

Automatic Selection

IBM United Kingdom Ltd. recently demonstrated a new electronic system that will retrieve within five seconds any one of a million printed or typed pages or photographs from a file centre. Known as Walnut, the system is the prototype of one being developed by IBM in America for the Central Intelligence Agency. In this system a tiny image of the document is photographically transferred to an IBM card so that the document can be viewed on a screen or printed out without removing it from storage.

Files are each loaded with up to 990,000 photographic images of documents that have been first microfilmed, then reduced to film strip. When information is required, key words are written on a form from which a punched tape is made and fed into the machine. A magnetic index is searched electronically, and a list of entries containing the key words is printed. The location of the document is then punched into an aperture card containing a blank film insert. The unexposed aperture cards are inserted into the document file which reads the location and brings the relevant part of the film strip into lens position, and from this the card's film insert is exposed and developed within about half a second. The document can then be read through a viewer or enlarged for printing.

IBM have also announced a new experimental application for computers to channel publications and other current information selectively to the people in an organisation most interested in the information. Called Selective Dissemination of Information, profiles or key words are chosen by a person to describe his interests. As documents are prepared, profiles are prepared on them also, listing the key words they contain. These key words are punched into cards and fed into the computer which matches the document profiles against the personal profiles and when a match is found generates a notification card to the person concerned.

Meet Mr. Smith, our chief vibrations engineer!

Open-form Construction

The new *Frampark* is London's first open-sided multi-storey ramp car park and will accommodate between six and seven hundred vehicles on eleven half-floors, arranged in two staggered tiers connected by cross ramps. All parking floors are open sided, with a white concrete grillage in place of windows, this open type of construction being new to Britain. To minimise obstruction by supporting columns, the floors consist of more than 1,100 pre-cast and pre-tensioned concrete T-beam units, each 33 ft. long by 30 in. wide and 10 in. deep, giving a headroom of 7 ft. between the floors in each tier. The external grillage, running the full length of each floor back and front, gives the building an unusual honeycombed appearance. The 500 white reinforced concrete columns and 950 cross members of this grillage were pre-cast in fibreglass moulds and bolted together on site. Decorative cherry-red panels are fitted between the columns at the level of each floor. Building and maintenance costs have been reduced by the open sided construction, which does away with the need for mechanical ventilation and fire sprinklers on every floor above ground.

Materials Research

The practical contacts of the *Building Research Station* with the behaviour of building materials soon reveal the troubles about durability and suitability of existing materials. The value of this station is that the staff have the experience to look at such problems in a basic fashion and to set about finding why materials are unsuitable for their purpose and consequently fail in use. When these are put on a scientific basis, procedures can be adopted and specified that will enable a soundly-based course of action to be adopted. The empirical approach is to test whatever appears on the market and attempt to pronounce which is the most suitable material for a particular purpose, a material which may never be outstanding in its performance.

A materials laboratory has another important function in a traditional industry, that of durability and the problem of accelerated trials. The Building Research Station will encourage and protect the pioneer user of new materials and methods—the more conservative users will follow suit. There is a determined effort by industry to invade the field of traditional building materials, particularly materials used in floor coverings, internal walls, ceilings, decorations, heat and sound insulating materials, furniture and all kinds of plumbing.

The use of structural materials is perhaps in a different category, and traditional steel and concrete techniques are likely to remain. Experiments are now being carried out in designing and erecting roofs with unconventional materials so that even load bearing structures will receive close study if lightness, durability and economy can be combined. Many of these new developments stem from the production of synthetic organic materials such as plastics, foams, fibres and elastomers, and equally new inorganic materials.